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A STUDY OF THE EFFECTS OF DIFFERENT LEVELS OF WINTER FEEDING OF NORTH AND SOUTH COUNTRY CHEVIOT EWE HOGGS ON THEIR GROWTH, DEVELOPMENT AND SUBSEQUENT PERFORMANCE.

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CONTENTS

LIST OF TABLES

Table		Between pages:-

LIST OF FIGURES

LIST OF APPENDICES

LIST OF PLATES

Plate

21. Pelvic bones dissected from S.C.C. animals born 1957.

22. Pelvic bones dissected from N.C.C. animals born 1957.

23. Limb bones dissected from S.C.C. animals born 1956.

24. Limb bones dissected from N.C.C. animals born 1956.

25. Limb bones dissected from S.C.C. animals born 1957.

26. Limb bones dissected from N.C.C. animals born 1957.

GENERAL INTRODUCTION

At the start of the present century there were traditionally two main methods of Cheviot ewe hogg wintering in the Border hills. One of these entailed preserving the two best quality and least exposed hirsels for the sole use of the hoggs (Smith, 1890). Used in alternate years, these hirsels were never stocked with ewes but had the excess growth grazed off by wether flocks in the spring and early summer. Thereafter they were rested until the keeping ewe lambs were introduced at weaning time. In this way the hoggs received a clean, fresh diet in the autumn and over the winter and were enabled to get a good start in life prior to joining the ewe flock. The other method was to send the ewe hoggs in the autumn to a less exposed hill farm or marginal farm where good mixed ground was laid aside specially for wintering them. These farms, known as hoggings (Robson, 1930 and Roberton, 1952) are now stocked with permanent Blackface flocks, the flockmasters being able to obtain a greater return from the production of Blackface lambs than could be obtained from the Cheviot hogg wool which represented the hogging rent.

This, along with the cessation of the heavy wether trade, has forced the Border hill flockmaster from the traditional ewe hogg winter management into the following two systems, namely, wintering at home on the hill with their dams or wintering away from home on a lowground arable and grass farm. In a survey of 33 Cheviot flocks in the Borders, Peart (1958) recorded 16 flocks that wintered all their hoggs on the hill, 8 that wintered all away from home and 9 that wintered part on the hill and part away. Obviously the quality of the wintering will vary from season to season and place to place but it is equally obvious that where hill wintering is practised the degree of hardship on the young growing ewe hogg must on occasion be very severe.

On the Hill Farming Research Organisation's farm of Sourhope, up the Bowmont Valley in Roxburghshire, a farm fairly typical of the harder upland Border country, hill wintered hoggs lose, on the average, 7 lb. (or 10 per cent) in weight ($\pm$ 5 lb.) over the winter at a time when they should be still actively growing. What effect this loss has on the growth, development and subsequent performance of these hoggs is not known and it is to study this that the present experiment has been designed.

REVIEW OF THE LITERATURE

Hill flockmasters and shepherds have long known the need to do ewe lambs well in their first winter for the better maintenance of a good ewe stock. Hogg wintering methods vary throughout the country depending on the sheep stock, the type of hill grazing, the rigours of the climate, the type of farming unit and the altitude.

In many cases on the higher, more exposed hill farms with little cultivated or improved land, the ewe hoggs are wintered away from home on lowground farms which can be anything up to 300 miles away. In recent years this has become expensive and frequently gives variable and uncertain results in the condition of the hoggs in the spring. In spite of this it still seems to pay many flockmasters to winter away, as, regardless of the effect on the hoggs, the resultant reduction in stocking on the hill benefits the ewe flock considerably. Hogg wintering at home on the hill appears to cause reduced growth, retarded maturation and considerable losses amongst the hoggs in addition to a poorer performance from the ewe stock. In fact, Wannop (1945), discussing hill sheep problems, stated that home wintering of ewe hoggs, if persisted in for several generations, may, in certain situations, produce a very inferior flock. Fraser (1937) thought likewise but went even further to say that it is easy to spoil ewe hoggs in their first winter by doing them either badly or too well. An error in either direction being reflected in the ewe stock for years thereafter.

The poor results to be obtained from wintering at home on the hill compared with away wintering have been demonstrated by Fraser (1937) and Brownlie (1954) with Blackfaces and Davies (1954-55) with Welsh Mountain. Davies, in this experiment and in a previous one (1950) has also shown the variability in performance resulting from away wintering at several different centres.

As an alternative to away wintering, many flockmasters are resorting to improvement and reseeding of sections of their hill grazings. The advantages of using these for the hoggs in preference to both away wintering and unsupplemented hill wintering have been well demonstrated by Smith (1949 and 1953-54) with Blackfaces and Davies and Hibler (1957) with Welsh Mountain.

The three main methods of hogg wintering practised commercially then are; hill, away and on reseed, increasing in value in that order. From the reports of several workers comparing results from these methods of wintering the following points emerge. Substantial live weight differences are created by the different wintering methods. Fraser (1937) reported that both hill and away wintered Blackface hoggs lost weight over the winter but the hill wintered to a greater degree. Brownlie (1954), also with Blackfaces, recorded an 8 per cent advantage in live weight in the spring for the away as compared with the hill wintered. Davies and Hibler (1957), with Welsh Mountain, comparing away wintering with home wintering on foggage over three years, reported an average difference of 11 lb. (or 20 per cent) in live weight in favour of the foggage. Other workers who have recorded live weight differences in the spring in favour of reseed wintering over away wintering and away over hill wintering are Smith (1949 and 1953-54), Munro (1954) and Davies (1954-55). In America, similar differences in live weight in the spring are reported by Esplin, et al. (1940) when they fed ewe lambs over three winters and compared them with normal range wintering.

No worker as yet has been able to prove what gain in live weight over the winter is ideal for any one particular set of conditions but both Brownlie (1954) and Davies (1954-55) suggest that a minimum gain of 15% is necessary for most satisfactory results in respect of future production.

All workers are agreed that over the summer poorly wintered hoggs make much greater live weight gains than those which have been well wintered. An explanation of this by Ragsdale (1934) suggests that undernutrition disturbs the normal relationship between chronological and physiological age in such a way that on a low plane diet, physiological age proceeds at a slower rate.

After altering from a low plane to a high plane diet the tendency is to grow at a rate appropriate to the physiological age rather than the chronological age, with the result that animals so treated grow faster than those of the same chronological age whose growth has not been retarded.

This phenomenon is well appreciated by stocksmen when buying wether lambs for fattening off the poorer upland hill farms, particularly at the end of a bad summer.

There are conflicting reports on the extent to which live weight differences created by different levels of wintering are overcome by the end of the summer and subsequently. Smith (1953-54), Brownlie (1954) and Davies (1954-55) all reported reduced but still present differences between their wintering groups in the autumn at $1\frac{1}{2}$ years of age. Smith went even further to state that in general his heavier animals at $1\frac{1}{2}$ years old remained so throughout their life. Brownlie qualified his report by stating that it was in the lightest hoggs that the weight difference was maintained at $1\frac{1}{2}$ years of age, in the heaviest the difference having disappeared. Brownlie also reported that a weight difference at $1\frac{1}{2}$ years was maintained to $2\frac{1}{2}$ years by those gimmers that were not pregnant or did not rear a lamb but was not maintained when a lamb was reared. Throughout this paper the term "gimmer" refers to the sheep between $1\frac{1}{2}$ and $2\frac{1}{2}$ years of age.

On the other hand, Munro (1954) reported that there was no permanent difference in live weight after $1\frac{1}{2}$ years between hill and lowground wintered hoggs which were substantially different at 1 year old. In America, Esplin et al. (1940) reported almost similar results from their experiments.

It is obvious from these various reports that the permanency of retardation causing live weight differences varies considerably with different conditions. This has been well summarised by Pomeroy (1955) who stated that the ultimate effect on live weight of a period of retarded growth probably depends on three main considerations:-

(a) The stage of growth at which retardation is applied.

(b) The severity of the retardation.

(c) The length of time during which retardation is imposed.

As Pomeroy put it, "The animal body shows considerable flexibility in recovering from a period of retarded growth, but if the retardation occurs early in life, when growth rate is high, and it is sufficiently severe and prolonged, permanent stunting may result." In the case of hogg wintering, the stage of growth when retardation is applied and the length of time it is imposed are fairly constant, therefore it is the severity of the retardation which is the primary factor in creating live weight differences.

Live weight in itself is not a good criterion for comparison between different levels of wintering as it gives little indication as to the size or conformation of the animals. It is possible for a short period of starvation to cause a considerable drop in live weight due to reduced gut fill without materially affecting the size or conformation as exhibited by the skeleton and musculature. Flockowners and scientists are well acquainted with the effects of various levels of hogg wintering on size and conformation, particularly in early life. Again the extent to which these effects are maintained in later life is open to doubt with varied opinions based mostly on visual examination. Fraser (1937) stated that with a poor winter diet the conformation is inclined to be lean and lanky, with narrow girth and thin bones, all of which tend to be retained throughout the animal's life. Brownlie (1954) also reported a marked difference in appearance in the spring between poorly and well wintered hoggs but Coop and Clark (1955) in New Zealand recorded a low plane diet from birth to 12 months, creating a 30 lb. live weight difference, as delaying but not suppressing the attainment of mature body size and weight as estimated by visual examination and weighing. In a similar experiment reported in the same paper by Coop and Clark, a low plane diet from 4 to 18 months, creating a 37 lb. live weight difference, resulted in the failure of these animals to overcome the difference in size, appearance and weight over a period of five years.

Palsson and Verges (1952) suggested as an explanation of this that a low plane of nutrition during the growing period of an animal's life lengthens the time needed for the animal to pass through the developmental changes and results in an early maturing animal taking on the form of a late maturing one. Palsson (1955) agreed with Pomeroy (1955) in that the extent and permanency of these changes depends very largely on the time of application, the severity and the length of time imposed, of the low plane diet. With hoggs, the type of wintering imposed and also the quality of the subsequent environment are obviously contributing factors to the variable results that have been reported in respect of permanency of stunting.

Where attempts have been made to measure the effects of different levels of feeding on size and conformation, the normal practice has been to record external live measurements. These have been used by many workers, e.g. Bonsma (1939), Hamada (1950), Large and Tayler (1954), King and Young (1955) and Cassard et al. (1956). According to Hammond (1932), however, external live measurements are primarily indices of length growth of skeletal parts and while they indicate trends in changes in size and conformation with age, they give no information as to the changes in weight or composition of the different parts of the body. Palsson (1955) quoted many workers who by studying external live measurements and live weight changes found that during postnatal growth live weight increased at a faster rate than any of the body measurements. This indicated that at birth the skeleton was relatively much better developed than the flesh which makes up the greatest proportion of weight in the full grown animal. In addition, the head, limbs and forequarters were relatively better developed at birth than the hindquarters.

Hammond (1932) carried this type of study even further, and by slaughter and dissection technique showed the differential growth rates present in the various organs, tissues and parts of the sheep's body. More recently, several workers have used Hammond's technique and have studied the effects of different levels of feeding on the growth and development of sheep with particular reference to meat carcass quality (Palsson, 1939 and 1940; Verges, 1939; Palsson and Verges, 1952; Wallace, 1948 and Barton and Kirton, 1958). All this work has shown how growth, development and the ultimate conformation of the sheep is dependent on the level of feeding during the growing period and also how limited is the use of external live measurements alone in demonstrating the true internal picture. This has been particularly well demonstrated in the case of the long bones of the skeleton, the later developing growth in thickness being retarded by poor nutrition in postnatal life to a much greater extent than the earlier developing length growth (Palsson and Verges, 1952). With hill sheep, however, where size, as depicted by the length measurements, can be of extreme importance, particularly on the harder hills, the use of external live measurements will still give a considerable amount of information.

In addition to live weight and size, most workers in comparing different levels of hogg wintering, have studied the effects on mortality and productivity. The usual aspects of production considered being wool, prolificacy and milking ability as depicted by lamb growth. In general it can be said that hogg mortality is reduced by a high level of winter feeding. Davies and Hibler (1957) recorded over three winters a loss of 2.1% from Welsh Mountain hoggs wintered at home on foggage compared with 5.7% from away wintered hoggs. Peart (1958), from a survey of commercial Cheviot hill flocks, reported a mean loss of 4.2% from hill wintered hoggs and only 2.5% from away wintered. This survey also showed reduced mortality amongst ewes which had been wintered away as hoggs. Other workers who have recorded reduced hogg losses from higher levels of winter feeding are Esplin et al. (1940), Munro (1954) and Coop and Clark (1955).

Wool clip as hoggs is increased to varying degrees by higher levels of winter feeding. Brownlie (1954), with an 8% difference in live weight between home and away wintered Blackface hoggs, reported a 7% difference in wool clip at the hogg clipping. Peart's (1958) survey recorded an increase of 0.6 lb. (14%) wool from away wintered hoggs over hill wintered, while Davies (1954-55) stated that Welsh Mountain hoggs well wintered could produce from $\frac{1}{2}$ - 1 lb. more wool (14 - 28%). Heavier wool clips from better wintered hoggs have also been reported by Esplin et al. (1940), Munro (1954) and Coop and Clark (1955). From these reports it would appear that the effect on wool clip has no lasting value beyond the hogg stage, subsequent clippings showing no difference between the treatment yields.

Barrenness appears to be reduced and prolificacy increased by a high level of winter feeding as hoggs. Esplin et al. (1940) in America recorded 64.7% of their well fed hoggs lambing at 2 years of age compared with 45.5% for their range group. Coop and Clark (1955) reported a similar but less obvious result, while Smith's (1953-54) work showed no significant difference in the percentage of unproductive ewes in either home wintered on reseed or away wintered groups. These differences can again be explained by the variation in degree to which the hoggs are retarded in growth by low levels of feeding. Phillips et al. (1945) in America studied the sexual development of range ewe lambs as affected by winter feeding and came to the conclusion that the diet of the ewe lamb during the first winter is a critical factor in determining reproductive capacity during the following year. A high level of feeding resulted in an increase in reproductive capacity and a reduction in death losses. These workers measured the size of the reproductive organs and recorded larger reproductive tracts and larger follicles in well fed hoggs, resulting in a reduction in barrenness and an increase in pregnancies during the gimmer year.

Similar results were recorded by Davies (1954-55) who stated that poorly wintered hoggs showed a greater tendency to inability to breed than well wintered hoggs, resulting in a greater percentage of barrenness. Davies considered that there was apparently a correlation between live weight performance during wintering and fertility in the first breeding season, lambing percentage being roughly proportional to the weight gained. These results seem to bear out the observation made by Palsson and Verges (1952) that the uterus and vagina are most affected by a limited nutritive supply during the later stage of development when the growth intensity of these organs is at its highest level.

At birth, according to Smith (1953-54), lamb weights were heavier from those gimmers which were wintered well and came out of their first winter heavier. However, Smith did not report any difference in percentage of lambs reared per live birth nor ewe lambs retained in each group. Davies (1950) reported the highest proportion of lamb deaths at or soon after birth from those gimmers which were worst wintered as hoggs. Coop and Clark (1955) also reported a slight but non-significant increase in lamb and ewe mortality resulting from low plane rearing. The same workers stated in addition that milk production of the ewes as measured by lamb growth rate was unaffected by the treatments. Owen (1957) has shown that milk yield is mainly dependent on nutrition just prior to and during lactation and also on the birth weight of the lamb.

In contrast to Smith, above, Coop and Clark (1955), with considerably greater treatment live weight differences, reported that the ewes which were reared on a low plane diet weaned 18% fewer lambs in their first productive year than the ewes reared on a high plane diet. In addition these workers reported 25% fewer lambs weaned in the ewes' lifetime from low plane rearing. Munro (1954), however, recorded no effect from different levels of hogg wintering on production after two years of age as shown by the conception rate of ewes and their ability to rear a lamb.

This can be explained in that while Munro and Smith were studying the effects of normal practice in hogg wintering with only limited differences in live weight, Coop and Clark were studying the effects of extensive and artificially imposed high and low plane diets. It would appear, therefore, that the extent of the lowering in productive ability in the gimmer year and subsequently is largely dependent on the degree of undernutrition in the first winter.

Little is known about the effects of a low plane diet on the long term productive life of ewes but Coop and Clark (1955) reported a reduction of from three to six months as measured by the rate of attrition of the incisor teeth. Wiener and Purser (1957), however, recorded a high plane diet resulting in an earlier eruption of the incisor teeth which seems more likely to reduce rather than increase the ultimate age at which severe attrition results in casting. Apart from the above reports nothing has been established regarding the effect of different levels of first winter feeding on the long term productive life of sheep. With cattle, however, Hansson (1953) reared identical twin dairy calves on high and low plane diets and recorded a high plane productive life of 75 months and a low plane productive life of 95 months. Pomeroy (1955), considering this, stated that it had not yet been conclusively demonstrated that there was a close correlation between a rapid growth rate and a good lifetime performance. It appears probable that for the best results in longevity of production there is an optimum rate of growth both above and below which efficiency is reduced.

From the foregoing review the following points arise, hogg wintering studies in respect of straight comparisons between two or more practical techniques have been carried out to a considerable extent on the Blackface and Welsh Mountain breeds but there is no record of any such work with the Cheviot breed. Live weight has been used in most cases to describe the differences created by the treatments and has been shown to be, by itself, unreliable in this respect. Size and conformation are probably of greater significance than live weight and have too often in hogg wintering studies in this country been considered on a visual basis. In America and New Zealand more critical work has been done on the effect of extreme levels of nutrition during the growing period and gives some degree of information with regard to their particular conditions. Where closer study has been made in this country on the growth and development of the sheep, more attention has been paid to the wether lamb for meat production than to the ewe lamb for flock replacement. While much of the information obtained in this way is relevant to growth and development in the female there are many side effects about which little is known. Namely, the effect of undernutrition on the development and shape of the pelvis with regard to its importance at parturition; the degree of recovery on hill grazings after a severe wintering in respect of bone, muscle and fat development; the eruption of the permanent incisor teeth leading to possible variations in casting age due to broken mouths; and the effect of forcing in early life on productive ability in the gimmer year and thereafter.

The intention in this experiment was therefore to study the effect of different levels of wintering of Cheviot ewe hoggs on their growth and development as depicted by live weight, live measurements and permanent incisor eruption with the slaughter and partial dissection of sample animals to give complementary information as to the internal development. In addition, full records were taken of all classes of production, namely wool, number of lambs and milking ability as depicted by lamb growth. For the purpose of this thesis it has not been possible to record the full life time productivity of the experimental animals but it is hoped that from the four years' records available sufficient information will have been collected to give some idea as to the probable trends occurring and also to the relationships existing between early and subsequent production.

MATERIALS AND METHODS

I Experimental material

On the Hairney Law hirsel of the Hill Farming Research Organisation's farm, Sourhope, in the Cheviot Hills, are run a mixed flock of approximately 130 South Country Cheviot and 140 North Country Cheviot ewes and gimmers for breed comparison purposes. The South Country Cheviot is the native (East) Border sheep and is so known to distinguish it from the North Country Cheviot in Caithness and Sutherland. The North Country Cheviot was introduced into the Border area shortly after the turn of the last century, largely due to virulent outbreaks of scrapie in the native South Country Cheviot breed and crosses (Roberton, 1952). Since then, the North Country Cheviot, a larger, more prolific and better milking sheep than the South Country Cheviot, has grown in popularity and does particularly well on the lower and less exposed hill farms and in fields (Robson, 1930). At Sourhope, the half hirsel of North Country Cheviots are being used to compare their performance on the higher, barer hills of the Cheviots with that of the native South Country breed.

It was therefore decided to use the ewe lambs for flock replacement in both breeds as the material for this experiment, enabling the relative responses of the two breeds to be studied.

Flock replacements over three successive years were used, the numbers retained in each year being:-

1956 - 42 S.C.C.	40 N.C.C.	) From this point	
		) on, South and North	
1957 - 39 S.C.C.	44 N.C.C.	) Country Cheviots will	
		) be designated S.C.C.	
1958 - 27 S.C.C.	30 N.C.C.	) and N.C.C. respectively.	

As the Hairney Law hirsel consists of two hefts, approximately equal numbers of ewe lambs were selected from each. Selection was done in the traditional manner by the farm staff at weaning time in August. In 1956 and 1957 a larger number of ewe lambs were retained than is customary in order to increase the numbers available for experimental grouping. This resulted in some smaller animals being kept with a corresponding decrease in the overall standard.

II Aims of the experiment.

The object of this experiment was to study the effect of different planes of nutrition during their first winter on the above two breeds, run under identical conditions.

1. By comparing growth and developmental differences created by the planes of nutrition over the winter feeding period, from 6 - 12 months of age.

2. By comparing the response exhibited after the above over the following summer period, from 12 - 18 months of age.

3. By comparing the extent and degree to which the differences created by the treatments are maintained in later life.

4. By comparing the productive performance resulting from the treatments, in the gimmer year in particular but also subsequently.

These main aims involved the following:-

(a) Examination of the live weight changes of the different treatment groups and of the heavy and light hoggs in the groups prior to treatment.

(b) Examination of the changes in skeletal size and conformation as depicted by live measurements, of the different treatment groups and of the heavy and light hoggs in the groups prior to treatment.

(c) Examination of the changes in bone shape, muscle development and fat deposition in certain joints of sample animals at 6, 12 and 18 months.

(d) Examination of wool production in the first year and subsequently.

(e) Examination of the eruption of permanent incisor teeth and their permanence and efficiency.

(f) Examination of mortality in the first year and subsequently.

(g) Examination of lamb production and milk production as depicted by lamb growth, in the first year and subsequently.

(h) Examination of lamb losses and ewe lambs retained in the first year and subsequently.

III Experimental design

The design of the experiment varied slightly each year and is therefore best described on a yearly basis.

Born 1956. Three planes of nutrition were fed to groups from both breeds, commencing at the time of the traditional November gathering and continuing until the first week in April when the hill herbage had started its spring growth. Group feeding was practised and the hoggs spent the whole winter penned indoors in a shed, this being the most practical means of feeding an experimental ration to hill sheep. The variability of the natural grazings was thus eliminated and a closer check could be kept on the nature and quantity of the feed consumed. The housing of hoggs over the winter is not a new idea. Wilson (1945) recorded an historical description of wintering hoggs in the North of England in specially built "hogguss" or hogg houses, most of which have now fallen into disrepair through being outdated. Symon (1959) has described the winter housing of all ages of sheep in the Highlands of Scotland prior to the start of extensive sheep farming some 200 years ago, while Robinson (1953 and 1956) has also reported the housing of sheep in Norway and Iceland where it is vitally necessary for their survival over the winter.

While it is perhaps not an ideal system of winter management with hill hoggs it is nevertheless increasing in popularity in some parts of this country as a cheaper alternative to away wintering, the hoggs being run out during the day and housed at night (Stewart, 1959 and Hendrie, 1960). The South Country Cheviot breed have a poor reputation amongst flockowners as regards housing, being temperamentally rather unsuited, so considerable attention was paid to the acclimatisation of the experimental hoggs in their winter quarters.

The three planes of nutrition were planned with the following objectives:-

1. High plane - To produce a gain of 10 - 15 lb. over the winter feeding period.
2. Mid plane - To maintain the initial weight with, if possible, a slight gain up to a maximum of 5 lb.

3. Low plane - To produce a loss of from 5 - 10 lb., simulating the average loss experienced at Sourhope in natural hill wintering.

Born 1957. In the light of experience gained with the 1956 experimental animals it was decided to commence the winter feeding at an earlier date, thereby allowing a longer period of time for the treatments to be imposed. Also, it was decided to feed only a high and a mid plane ration indoors, leaving the third group in each breed to run on the hill as a natural hill wintered control. The commencement of the winter feeding was timed to coincide with the dropping off in condition of the hill grazings, the intention being to maintain as nearly as possible the steady growth of the animals intended for high plane feeding. In this particular year, the last week in September was considered to be the optimum time for commencement of the winter feeding.

The three groups then were:-

1. High plane - Fed ad lib. to grow to their maximum potential.
2. Mid plane - Fed as for the 1956 mid plane groups.
3. Hill group - Wintered on the hill with the main flock.

Born 1958. To complete the picture of hogg wintering in the Borders as described by Peart (1958), it was decided this year to away winter on a low ground grass and arable farm half the replacement ewe hoggs from each breed. The remaining half were wintered at home on the hill and received the same management as the main flock.

IV General management and feeding

As the management of the experimental animals and the rations fed to them varied each year, they are described here again on a yearly basis.

Born 1956. After selection at weaning, the ewe lambs were returned to the hill with their dams, where they received the routine hill management until the end of October, a week before the start of the experimental feeding period. All were dosed against worms with Phenothiazine and vaccinated against pulpy kidney and braxy. For one week they were run together in a grass field by day and received hay ad lib. as an introductory diet. Then they were penned and all received hay ad lib. plus 2 oz. of a concentrate mixture per day for another week. The concentrate ration was designed to provide a protein rich supplement to the hay ration and consisted of bruised oats, linseed cake and fish meal in the ratio of 7 : 2 : 1. This mixture supplied energy and protein in the ratio of just below 4 : 1 and was considered, with the hay supplying approximately 10 : 1, to provide a balanced ration suitable for efficient growth and development. A mineral mixture with a vitamin supplement was initially added to the concentrate ration at the rate of 5%. The mineral mixture used was a proprietary one, Churn Brand 101 P, containing phosphorus, phosphoric acid, calcium, sodium, chlorine, iron, magnesium, manganese, copper, cobalt and iodine. The vitamin supplement was also a proprietary one and contained vitamins A and D. Water was offered in every case.

The rations fed after the first week to each treatment group are shown in detail in Appendix II and only the general technique will be discussed here. All ration alterations were based on observations made on three-weekly weighings. The high plane groups received hay ad lib. and a gradually increasing amount of concentrates until the second week in February at which point the S.C.Cs. were consuming 10 oz. of concentrates per day and the N.C.Cs., now starting to show their potential for greater size, 12 oz. per day. As the live weight gains being achieved by the high plane groups on this ration were considered to be somewhat low, it was decided to alter the hay from an ad lib. ration of poorish quality ($5\frac{1}{2}$% C.P.) to 1 lb. per day of good quality (11% C.P.) fed in the morning plus $1\frac{1}{2}$ lb. per day of the poorer sample fed in the evening. The oat sample used in the concentrate ration was also considered to be rather too fibrous so the mixture was altered to bruised oats, flaked maize, linseed cake and fish meal in the ratio of 4 : 3 : 2 : 1. This provided approximately the same amount of protein as the previous mixture but increased the amount of available and easily assimilated energy without upsetting the balance of the nutrients; the energy-protein ratio standing at just over 4 : 1. The rate of feeding of the new mixture was increased to a maximum of 12 oz./head/day for the S.C.C. high plane group and 16 oz./head/day for the N.C.C. high plane until the end of the feeding period.

The mid plane groups received 2 lb. of the poor quality hay per day throughout the feeding period with the exception of a month in January - February when the S.C.C. group were fed only $1\frac{3}{4}$ lb. Two ounces of the concentrate ration were fed per day until the mixture was altered and then the S.C.Cs. received 3 oz. and the N.C.Cs. 4 oz. as a maximum.

After the first week the low plane groups received no concentrates and had their hay ration decreased to 2 lb. of the poor quality sample per day. This was further reduced to 1 lb. of hay and 1 lb. of oat straw but even on this ration the required loss in weight was difficult to achieve in the S.C.C. group. Even further reduction was therefore made in this group to $\frac{3}{4}$ lb. hay and $\frac{3}{4}$ lb. oat straw. These levels of feeding were maintained until the danger of losses from starvation in both breeds made it necessary to increase the ration back to 2 lb. of hay at which level it remained until the end of the feeding period.

When the concentrates were withdrawn from the low plane groups, minerals and vitamins were omitted from the mixture and were offered in boxes to all groups. A careful watch had to be kept on the low plane groups when their rations were reduced to just above starvation level, as the hoggs showed an inclination to eat excessive quantities in an attempt to satisfy appetite. Minerals and vitamins were therefore offered only occasionally to these groups during the later stages of the feeding period.

For a week prior to being returned to the hill at the beginning of April all groups were run out during the day on a grass field and penned at night with hay offered as a supplement to their grazing. On returning to the hill the experimental animals joined the main flock and from then on received the normal hill management with no preferential treatment.

Born 1957. The management and feeding of the 1957 experimental ewe hoggs differed from that of the 1956 age group in the following ways. The object this year was to feed only a high and a medium plane group from each breed indoors, with hill wintered groups as controls. An earlier start to the experimental feeding was intended and with the high plane groups, full expression of their potential for growth and development was planned, with a certain degree of fatness permissible. After weaning in August, all the experimental ewe hoggs selected were returned to the hill with their dams. Dosing against worms with Phenothiazine and vaccination against pulpy kidney and braxy were carried out as is customary. At the end of September, all the hoggs were brought in for grouping, after which the hill wintering groups were returned to the hill. The indoor feeding of the high and mid plane groups is described in detail in Appendix III. Here, as with the 1956 experiment, only the general technique will be discussed.

Hay and concentrates were both offered as an introductory diet over the first two weeks of October. No difficulty was experienced in getting the animals to eat the artificial diet. The hay sample used this year was of medium quality, containing approximately 7% C.P., while the concentrate ration was the same as was used in the latter part of the 1956 feeding period, namely 4 parts bruised oats, 3 parts flakes maize, 2 parts linseed cake and 1 part fish meal. Minerals plus vitamins were offered at periodic intervals throughout the feeding period and water was available at all times.

With the high plane groups more stress was put on the concentrate intake with the hay ration providing the extra bulk to satisfy appetite. Concentrates were offered in ever increasing amounts and any indication of an inability to consume all that was offered was accompanied by an immediate decrease in the quantity of hay fed. In this way, by the middle of January, the S.C.C. group were consuming 22 oz. of concentrates per day and the N.C.C. group 24 oz. From 1 - 1½ lb. of hay were also being eaten by both groups. To avoid an undesirable state of overfatness it was decided to restrict the concentrate intake to this level for the remainder of the feeding period. With such large quantities of dry food being consumed it was considered necessary in December to add one part of bran to the concentrate mixture. This acted as a mild laxative and had a general tonic effect.

The mid plane groups' intake of hay and concentrates was regulated, as in 1956, with regard to the live weight status recorded every three weeks. On the average, 2 lb. of hay were fed throughout and from 2 - 8 oz. of concentrates, as required.

The hill wintered groups remained all winter with the main flock and received no preferential treatment. In the latter part of the winter, half the mainflock were offered a small concentrate supplement and half a small hay supplement as part of the routine hill winter feeding experiment, but as little or no advantage seems to accrue from either of these supplements over the other and as the hill groups were evenly divided between them, it was considered unnecessary to attach any importance to this difference in treatment.

At the end of the winter feeding period in April the high and mid plane groups were returned to the hill after a few days acclimatisation by being run out during the day and penned at night with a supplement of hay and concentrates. Thereafter they received the routine hill management.

Born 1958. No experimental indoor feeding of the keeping ewe hoggs was planned for this year's study. A straightforward comparison between hill wintering representing a low plane and away wintering representing a mid to high plane was designed to give complementary information to the first two years' work.

After selection in August, the keeping ewe hoggs were returned to the hill with their dams where they remained until the middle of October. Routine dosing and vaccination was carried out as in the previous two years. After grouping in October, the hill wintering hoggs were returned to the hill while the away wintering ones were grazed on grass fields until the beginning of

December when they went off to a low ground grass and arable farm in Berwickshire. The hill wintered hoggs received the same routine management as was described for the 1957 hill wintered groups. One visit was made to the away wintered hoggs in January in order to complete the vaccination programme against braxy. At the end of the first week in April these groups returned to Sourhope and after a day or two's acclimatisation in a field were turned out on the hill to join the mainflock.

V Methods of investigation

In order to study the effects of the foregoing treatments on the experimental animals, collection of the following data was carried out.

1. Live weights.
2. Live measurements.
3. Fleece weights.
4. Eruption of the permanent incisor teeth.
5. Mortality.
6. Lamb production.
7. Dissection data from selected animals in each group and breed.

Only the methods employed in recording the above and the reasons for their selection are discussed here, more detailed management and timing are described in the next section.

1. Live weights were recorded to the nearest pound on an Avery scale. They are the most common means of recording differences resulting from treatment in animal research and while they do give a degree of information as was discussed in the Review of Literature they do not alone show the variations in size that can occur.

2. Live measurements were therefore recorded to provide detailed information regarding size as depicted by skeletal growth and also to some extent by condition. The instruments used to record the following measurements were a pair of callipers with a scale calibrated in cms. and sub-divided into 2 mm.

divisions, a linen tape scaled in cms. and a metre rule.

The measurements recorded were as follows:-

(a) Heart girth, measured with a cord, read to 0.5 cm. against the metre rule. In measuring, the wool was split to enable the cord to lie against the skin, thereby eliminating excessive variation due to wool thickness. This measurement is closely related to condition and therefore may also be related to live weight (Joubert, 1954).

(b) Body length, measured with the callipers, read to 0.5 cm., from the head of the humerus to the tuber ischii. This measurement is open to great variation depending on the stance of the animal. Great care was therefore taken to ensure a uniform stance for every sheep. A general size measurement.

(c) Pelvis length, measured with the callipers, read to 0.1 cm., from the tuber coxae to the tuber ischii.

(d) Pelvis width, measured with the callipers, read to 0.1 cm. across the tuber coxae.

The pelvis, being one of the latest developing bones in the body, is likely to be severely affected by an adverse wintering treatment. Its size may therefore be of great significance, particularly when its importance in parturition is considered.

(e) Fore-leg length, measured with the linen tape, read to 0.5 cm. from the olecranon process to the ground, with the sheep standing upright. Like body length this is a general size measurement and was recorded as it is one of the most obvious differences existing between North and South Country Cheviots.

(f) Fore-cannon length, or metacarpal length, measured with the callipers, read to 0.1 cm. One of the earliest maturing bones in the body and also one of the easiest and most accurate to measure.

(g) Tibia length, measured with the callipers, read to 0.1 cm. The longest and one of the most easily measured limb bones. A later developing bone than the cannon bone.

3. Fleece weights. The weight of wool clipped from the experimental sheep at the routine clipping gathering in June was recorded in the hogg year after treatment and also in subsequent years.

4. Eruption of the permanent incisor teeth. To examine the effects of treatment on time of eruption of the first pair of permanent incisors and also of subsequent pairs, periodic examinations of the dentition were carried out. A simple scale of scoring was designed to illustrate the degree and number of permanent incisors erupted at any one time of recording. This consisted of three marks for each P.I. fully erupted, two marks for each half erupted and one mark for each milk tooth missing and/or each P.I. commencing to erupt.

5. Mortality. All losses from natural causes throughout the winter feeding period and subsequently were recorded and where possible were sent for post mortem to determine the causative factor.

6. Lamb production. At lambing in the gimmer year and also at subsequent lambings, all of which took place on the hill, full records of barrenness and lamb production were taken. These were date of birth, single or twin, dead or alive, weight of lamb at birth and sex of lamb. Losses of lambs between birth and weaning, lamb weights at marking and weaning and ewe lambs retained at weaning were also recorded.

7. Dissection data from selected animals in each group and breed. This applied only to the 1956 and 1957 experimental age groups. The object being to get detailed information on the internal structure of the body resulting from treatment in respect of muscle, fat and bone. The method of selecting the animals for slaughter and dissection and the detailed procedure followed are discussed in the next section, only the general technique and objectives are explained here.

From a study of the work of Hammond (1932), Palsson (1939 and 1940) and Palsson and Verges (1952) on the dissection of sheep carcasses it was apparent that complete dissection of the selected animals was a task which with the time and staff available was not possible. It was therefore decided that the most useful information would be obtained from dissecting the hindquarters only, from the loin backwards. This would give detailed information on pelvic development which is of particular importance in this study and on the relative development of two joints of differing growth rates, namely the loin and the leg. To reduce the jointing error and give a mean value, both legs were dissected.

The following general information was recorded prior to dissection:-

Live weight, unfasted and fasted
Weight of skin plus wool
" " head
" " digestive system
" " mesenteric or omentum fat
" " carcass, hot and cold
" " heart
" " heart fat
" " liver
" " lungs and trachea
" " uterus and vagina plus ova
" " eyes
" " brain.

The four cannon bones were dissected out of the feet and scraped clean for weighing and measuring. A photographic record was taken of the dorsal and ventral views of the carcass prior to cutting, then the hindquarters were split from the forequarters by a transverse cut between the last thoracic and the first lumbar vertebrae. The two halves of the carcass were weighed separately.

The sixth rib was removed for cleaning and measuring to give an indication of the effect of treatment on rib growth, the ribs being the latest maturing bones in the body (Palsson and Verges, 1952).

A photographic record was taken of the dorsal view of the hindquarters with the kidneys and kidney fat exposed, separation into joints was then carried out. Palsson's (1939) technique was used as it separated the hindquarters into anatomical joints and not into butcher's joints as in the technique employed by Hammond (1932). After removing the kidneys and kidney fat for separation and weighing, the jointing procedure was as follows:-

Loin. Divided from the gigots by a transverse cut on each side, at the level of the anterior extremity of the ilium wing (hip bones). The inside curve of the latter was then followed and the vertebral column severed at the junction of the last lumbar vertebra with the sacrum.

Legs. A transverse cut was made directly through the muscles at the level of the anterior edge of the symphysis pubis. The two legs were then separated by a cut along the posterior median line to the symphysis ischium, laying bare the surface of the gracilis muscles on each side. The femur-acetabulum joint was then severed. Working from the symphysis ischium, the gracilis and adductor muscles were separated from the ventral surface of the ischium. The ischial arch and the postero lateral angle were then followed to the acetabular branch of the ischium, working as close to the bone as possible and severing the biceps femoris and semi-tendinosus muscles at their attachments. A circular cut was then made from the acetabulum through the musculature of the thigh to meet that previously made from the flank at the level of the symphysis pubis.

Pelvis. That which remained.

Each joint was weighed separately and then dissected into its component tissues, sub-cutaneous fat, intermuscular fat, muscle, tendon and bone. On the completion of each joint, the total weights of the individual tissues were recorded to the nearest gramme. The tail was included in the pelvis joint but was weighed as a complete unit and not dissected into the different tissues. All bones were scraped clean and after weighing were labelled for future identification and measuring. The measurements recorded were; on the long bones, i.e. the femurs, the tibias and all four cannons, length and minimum circumference; on the pelvis, length from tuber coxae to tuber ischii, width across the tuber coxae, width across the femur-acetabulum joints at the widest point, width across the tuber ischii and the internal width of the pelvic cavity at its widest point; on the sixth rib, length in a straight line from one extremity to the other and "spring" from this line to the outermost point on the curve of the rib. All bones were photographed to a standard size against a centimetre squared background.

VI Detailed management of investigational technique

Having discussed in the foregoing section the methods employed in studying the effects of treatment, it is now intended to describe the management and timing of the recording technique.

1. Live weights. Prior to the start of the experimental treatments in all three years (1956, 1957 and 1958), live weights were recorded on all the lambs at birth, marking (3 - 6 weeks) and weaning (14 - 17 weeks). Immediately before the treatments commenced a further record was taken to assist in grouping. All indoor fed hoggs in the 1956 and 1957 experiments were weighed at three-weekly intervals throughout the winter feeding period as a guide to the effectiveness of the various rations. The hill wintered groups in 1957 and 1958 were weighed at the routine hill gatherings early in November and at the end of the year while the away wintered groups in 1958 were weighed just prior to going away early in December. A further weight record was planned to be taken on these animals in January at their wintering farm but a fault developed in the balance being used and it was not possible to arrange another visit.

At the end of the wintering all groups were weighed prior to returning to the hill in April and thereafter the weighing programme followed the routine pattern for the mainflock, namely, late May, mid August, early November, late December and late March.

2. Live measurements were recorded immediately before the commencement of

the winter treatments at the same time as the weighing and with the same object of aiding group selection. All measurements were taken twice by the author in order to study the degree of repeatability of the individual measurements. Further single recordings were taken at the end of the winter treatments in April, after clipping in June, prior to tupping at 18 months of age in November and after each subsequent clipping.

3. Fleece weights. As hoggs, the clipping was carried out by the farm staff, while subsequent clippings were performed mainly by a specialised clipping squad. No two operators clip exactly the same amount of wool but the range of operator error within any group was sufficiently identical to be ignored when comparing means.

In the 1956 experiment, while examining the best technique of recording live measurements, a groove was cut in the wool of the N.C.C. high plane animals in an attempt to simplify the measuring of heart girth. This proved to be rather impracticable and of no real advantage so was not repeated on any of the other groups. It did, however, result in a smaller clip of wool from these animals at clipping partly because of the removal of the strip of wool but mainly because the break created in the fleece led to early and considerable peeling or casting of the wool.

4. Eruption of the permanent incisor teeth. As the normal time in sheep for the eruption of the first pair of permanent incisors is somewhere between 12 - 15 months of age (Brown, 1949), examination of the mouths did not commence until the end of the winter treatment periods in April. Further examinations were made at each of the routine gatherings in June, August and November. In subsequent years, examinations for the eruption of the second, third and fourth pairs of P.Is. were made at similar times.

5. Mortality. Two mild cases of "yellowses", or photo-sensitisation, were included amongst the experimental animals in 1956. Unfortunately both lost their ears during the winter treatments and had therefore to be removed from the

experiment when indoor feeding ceased. Their performance over the winter has been included in the results but their loss has not been considered as mortality when comparing treatments.

During their second winter, two gimmers from the same age group were buried and died in a severe blizzard, they have also been omitted from the mortality records when comparing treatments.

6. Lamb production. The recording of lambs on the hill entailed catching them within a few hours of birth and attaching ear number tags. Their dams were identified by large plastic number plates suspended on leather straps round the neck. Multiplicity, sex and weight were also recorded at this time. Birth weights were read to 0.1 lb. on a small spring balance. Marking weights were recorded on a larger spring balance read to the nearest pound while weaning weights were recorded on the big Avery scale used for weighing adult sheep.

7. Dissection data from selected animals in each group and breed. The following description of the dissection procedure applied to both the 1956 and 1957 experimental age groups. Before the start of the winter feeding, two animals from each breed were selected for dissection to provide a pre-treatment base-line in respect of size and development at six months of age. At the end of the winter feeding, one animal from each treatment group in each breed was selected to depict the effects of treatment on size and development at one year old. Again, after the summer period, at 18 months of age, one animal/treatment group/breed was selected to illustrate the effects of a similar summer environment following various winter treatments.

Each dissection series followed the same pattern. After weighing and photographing, two selected animals were transported by road every second day from Sourhope to Gorgie Slaughterhouse in Edinburgh. There they remained overnight in a fasting condition and were slaughtered after weighing first thing in the morning. Slaughtering was carried out by slaughtermen employed by the Fatstock Marketing Corporation, under supervision from the author. The skins, feet, digestive systems, mesenteric fat and hot carcasses were weighed at the time of slaughtering after which the carcasses were hung up to cool. While they were cooling, the contents of the thoracic cavity, the sexual organs and the feet were taken in polythene bags for dissection in the Edinburgh School of Agriculture post mortem room on the Bush estate. There the heart, heart fat, liver, lungs + trachea, uterus + vagina + ova and cannon bones were separated out and weighed. The two cooled carcasses were then transported to the Bush where the heads were removed and one carcass was stored in a refrigerator until required. The eyes and brains from the heads were dissected out and weighed, the heads then being discarded. Photographing, measuring, jointing and dissection were then carried out on the first carcass. All joints and tissues were kept carefully covered with damp towels during dissection to reduce loss of moisture by evaporation. Scissors, scalpels and forceps were the instruments used by the dissection team which varied in size from time to time from 4 - 7 persons. Where possible, only one joint at a time was dissected and its tissues were gathered on one tray until completed and the weights of the tissues were checked against the total weight before dissection. This ensured that any errors in weighing could be corrected before the tissues lost their identity or were discarded.

The actual technique of dissection entailed the removal of subcutaneous fat from the outside of the joint, separation of the various muscle bundles so that intermuscular fat could be isolated and the scraping of tendon, muscle and connective tissue from the bone.

On the completion of the first carcass, the second was removed from the refrigerator and the procedure repeated. On the average, from slaughter to completion, it took two days for two animals, the next two being slaughtered on the third morning. Where the total was six, the third pair were slaughtered on the fifth morning.

VII Methods of selection

1. Selection of animals for dissection prior to treatment. Here the intention was to select two animals from each breed which would illustrate as closely as possible the average size, shape and condition of both breed types at six months of age. As the selection of two at random could so easily result in the choice of atypical samples, it was decided to base the selection on the breed means of live weight and live measurements as recorded at that time. In this way, the two animals in each breed most closely approximating to these means and typical of the breed type in appearance were selected for dissection.

2. Selection of groups. After the removal of the above animals for dissection, the remainder were split into three groups of approximately equal numbers for the three treatments. This applied to the 1956 and 1957 experiments, in 1958, where there were no dissections and only two treatments, the same principles were used to split the experimental animals into two groups.

Selection for treatment groups was slightly different and considerably more complicated than selection for dissection. Here again a random selection was considered to be rather unsuitable with the limited numbers available in the experiment. In addition to variations in size, shape and condition as depicted by live weight and live measurements there were several genetic and environmental factors which could cause differences and might cloud the treatment effects unless evenly distributed. These were the genetic make up of the dams, the heft or side of the hill on which born and whether single or twin. It was therefore decided that to eliminate these possible variables, selection should be based on the equalisation within groups of live weight, left fore-cannon length, pelvis length and width, heft born on, age of dam and single or twin. Details of origin and history of animals allocated to treatment groups are shown in Appendix I.

3. Selection of animals for dissection after treatment at 12 and 18 months. This was carried out in the same manner as described for the pre-treatment dissections in section VII, 1, above. Here the sole difference being that

only one animal/treatment group was selected as being representative of the group, making a total of 6 sheep (3 from each breed) for dissection at each age.

VIII Technique of statistical analysis

Analysis of differences in live weight and live measurements resulting from treatment.

Analysis of variance and analysis of covariance were the techniques employed and were carried out in the fashion described by Snedecor (1956).

The means, the sums, the sums of squares and products and their respective correction terms were calculated for each treatment group, i.e.

$$n.\ \bar{x}.\ \bar{y}.\ SX.\ SY.\ SX^2.\ SY^2.\ SXY.\ \frac{(SX)^2}{n.}\ \frac{(SY)^2}{n.}\ \frac{(SX)(SY)}{n.}$$

where n = number of animals in each group

X = initial weight or size at start of experiment

and Y = weight or size at any subsequent recording.

The totals for any one time of recording were obtained by addition of the above data for each treatment group. Total and group sums of squares and products were then calculated by subtracting the corresponding correction terms for the total X, Y and XY.

Where there were three treatment groups as in the 1956 and 1957 experiments, the complete computation took the form:-

$$n_1.\ \bar{x}_1.\ \bar{y}_1.\ SX_1.\ SY_1.\ SX_1^2.\ SY_1^2.\ SX_1Y_1.\ \frac{(SX_1)^2}{n_1.}\ \frac{(SY_1)^2}{n_1.}\ \frac{(SX_1)(SY_1)}{n_1.}$$

$$n_2.\ \bar{x}_2.\ \bar{y}_2.\ SX_2.\ SY_2.\ SX_2^2.\ SY_2^2.\ SX_2Y_2.\ \frac{(SX_2)^2}{n_2.}\ \frac{(SY_2)^2}{n_2.}\ \frac{(SX_2)(SY_2)}{n_2.}$$

$$n_3.\ \bar{x}_3.\ \bar{y}_3.\ SX_3.\ SY_3.\ SX_3^2.\ SY_3^2.\ SX_3Y_3.\ \frac{(SX_3)^2}{n_3.}\ \frac{(SY_3)^2}{n_3.}\ \frac{(SX_3)(SY_3)}{n_3.}$$

Totals. $n_t.\quad SX_t.\ SY_t.\ SX_t^2.\ SY_t^2.\ (SXY)_t.\ \left(\frac{(SX)^2}{n}\right)_t\ \left(\frac{(SY)^2}{n}\right)_t\ \left(\frac{(SX)(SY)}{n}\right)_t$

Correction Terms. $\frac{(SX_t)^2}{n_t.}\ \frac{(SY_t)^2}{n_t.}\ \frac{(SX_t)(SY_t)}{n_t.}\ \frac{(SX_t)^2}{n_t.}\ \frac{(SY_t)^2}{n_t.}\ \frac{(SX_t)(SY_t)}{n_t.}$

Total and Group Sums of Squares and Products. $TSx^2.\ TSy^2.\ TSxy.\ GSx^2.\ GSy^2.\ GSxy.$

Analysis of variance of X was then as follows:-

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square
Groups	2	GSx^2.	$\frac{GSx^2}{2} = GMS.$
Error	n_t-3	TSx^2-GSx^2.	$\frac{TSx^2-GSx^2}{n_t-3} = EMS.$
Total	n_t-1	TSx^2	

$$\therefore F = \frac{GMS.}{EMS.}$$

Analysis of covariance and test of significance of adjusted group means were then calculated.

Source of Variation	Degrees of Freedom	Sums of Squares and Products	Adjusted Sum of Squares	Degrees of Freedom	Adjusted Mean Square
Total	n_t-1	TSx^2. $TSxy$. TSy^2.	$TSy^2-\frac{(TSxy^2)}{TSx^2}$	n_t-2	
Groups	2	GSx^2. $GSxy$. GSy^2.			
Error	n_t-3	TSx^2-GSx^2. $TSxy-GSsy$. TSy^2-GSy^2. $= ESx^2$. $= ESxy$. $= ESy^2$.	$ESy^2-\frac{(ESxy)^2}{ESx^2}$.	n_t-4	AEMS.
			AGSS.	2	$\frac{AGSS.}{2}$

$$AGSS. = \left(TSy^2-\frac{(TSxy)^2}{TSx^2}\right)-\left(ESy^2-\frac{(ESxy)^2}{ESx^2}\right)$$

$$AEMS. = \frac{ESy^2-\frac{(ESxy)^2}{ESx^2}}{n_t-4} \qquad \therefore F = \frac{\frac{AGSS.}{2}}{AEMS.}$$

The regression coefficient, $b = \frac{ESxy}{ESx^2}$ was used to calculate the adjusted group means:-

$$\bar{y}_1 - b(\bar{x}_1 - \frac{SX_t}{n_t}) = \text{adjusted } \bar{y}_1.$$

$$\bar{y}_2 - b(\bar{x}_2 - \frac{SX_t}{n_t}) = \text{ " } \bar{y}_2.$$

$$\bar{y}_3 - b(\bar{x}_3 \quad \frac{SX_t}{n_t}) = \text{ " } \bar{y}_3.$$

Adjusted error mean square = AEMS. = variance. When this was significant, the differences between each treatment group were tested for significance as follows:-

Variance of difference between any two group means with

n_1 and n_2 individuals. = AEMS.$\left(\frac{1}{n_1} + \frac{1}{n_2} + \frac{Dx^2}{ESx^2}\right) = (S.E.)^2$.

Dx = difference between group means at X.

Dy = difference between adjusted means. S.E. = Standard error.

$\therefore t = \frac{Dy}{S.E.}$, with $n_t - 4$ degrees of freedom.

The same procedure was followed when there were only two treatment groups as in the 1958 experiment.

Analysis of the differences resulting from treatment in the heavy and light hoggs in each group initially was carried out in exactly the same manner. The means, sums, sums of squares and products and their respective correction terms being calculated for the heavy hoggs in each group and also for the light hoggs in each group.

RESULTS

I Introduction

The various components of growth, development and production and the effects of treatment on them in the three experimental age groups are examined in the following sections. Growth and development has been studied for the total treatment groups and also for the heavy and light hoggs within each group prior to treatment. The latter differentiation was based on pre-experimental live weights, all hoggs above the mean weight being called heavy and all below it being called light. The effects of treatment on live weight and live measurements have been examined both for the total groups and for the two weight classes over three separate periods; the treatment period, 6 - 12 months; the summer after treatment, 12 - 18 months; and from 18 months onwards.

II Live weight

1. Treatment period, 6 - 12 months

(a) Total groups. The actual mean live weights recorded over the treatment period in each experimental year are shown in Table 1 and illustrated in Figs. I, Ia and Ib. Total and percentage gains over the treatment period are shown in Table 2. Adjusted means from covariance analysis and the significance of differences between them are shown in Table 3. Photographs of the 1956 and 1957 born treatment groups at the end of the treatment period are shown in Plates 1, 2, 3 and 4.

Born 1956. Over the treatment period of 22 weeks, the H.P. groups, S.C.C. and N.C.C. respectively, gained 12.7 lb. (18.8%) and 14.7 lb. (19.9%) over their initial weights; the M.P. groups approximately maintained their initial weights with a slight drop of 1.4 lb. (2.1%) for the S.C.C. group and a very slight increase of 0.8 lb. (1.1%) for the N.C.C.; while the L.P. groups lost 7.2 lb. (10.8%) and 7.7 lb. (10.4%) for S.C.C. and N.C.C. respectively. These were the range of changes intended (see Experimental Design in section III of Materials

Table 1

Mean live weights over treatment period (lbs.)

Born 1956

Mean Age in weeks	S.C.C. Pre-experiment records*	S.C.C. H.P.	S.C.C. M.P.	S.C.C. L.P.	N.C.C. Pre-experiment records*	N.C.C. H.P.	N.C.C. M.P.	N.C.C. L.P.
27		67.5	67.0	66.5		74.0	74.2	74.0
29	63.4	63.7	62.5	63.5	69.0	69.5	71.0	71.7
32		68.1	64.4	66.3		72.1	74.1	74.8
35	62.2	68.1	65.2	64.1	70.2	74.7	74.5	73.8
38		71.7	64.2	63.5		77.2	74.0	70.3
41		72.2	64.2	61.7		76.4	74.5	66.8
44		74.7	64.7	60.7		80.8	74.5	69.5
47		77.8	62.9	57.6		84.7	74.2	64.7
49	56.4	80.2	65.6	59.3	61.7	88.7	75.0	66.3

Born 1957

Mean Age in weeks	S.C.C. Pre-experiment records*	S.C.C. H.P.	S.C.C. M.P.	S.C.C. Hill	N.C.C. Pre-experiment records*	N.C.C. H.P.	N.C.C. M.P.	N.C.C. Hill
22		62.7	64.6	62.4		69.9	69.2	69.4
24		64.5	65.7	-		70.6	70.9	-
28	63.4	62.6	62.1	65.1	69.0	69.2	68.2	70.8
32		61.1	60.6	-		70.0	65.1	-
35	62.2	64.8	63.7	65.8	70.2	73.6	69.9	69.1
38		67.7	64.8	-		75.3	72.1	-
41		71.5	66.3	61.6		79.5	73.1	65.6
44		75.4	66.2	-		83.9	71.4	-
47		80.2	67.3	-		89.3	75.1	-
49	56.4	82.3	66.3	56.1	61.7	92.6	73.3	59.1

Born 1958

Mean Age in weeks	S.C.C. Pre-experiment records*	S.C.C. Away	S.C.C. Hill	N.C.C. Pre-experiment records*	N.C.C. Away	N.C.C. Hill
25		57.6	56.9		60.4	60.3
30	63.4	62.5	61.5	69.0	66.1	65.4
35	62.2	-	61.1	70.2	-	66.0
49	56.4	66.7	59.6	61.7	70.5	64.8

* Mean of 5 years' records.

Table 2

Actual and percentage mean live weight gain over treatment period

	S.C.C.			N.C.C.		
Born 1956	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.
Gain in lb. over 22 weeks	12.7	-1.4	- 7.2	14.7	0.8	- 7.7
%-age gain	18.8	-2.1	-10.8	19.9	1.1	-10.4
Born 1957	H.P.	M.P.	Hill	H.P.	M.P.	Hill
Gain in lb. over 27 weeks	19.6	1.7	- 6.3	22.7	4.1	-10.3
%-age gain	31.3	2.6	-10.1	32.5	5.9	-14.8
Born 1958	Away	Hill		Away	Hill	
Gain in lb. over 24 weeks	9.1	2.7		10.1	4.5	
%-age gain	15.8	4.7		16.7	7.5	

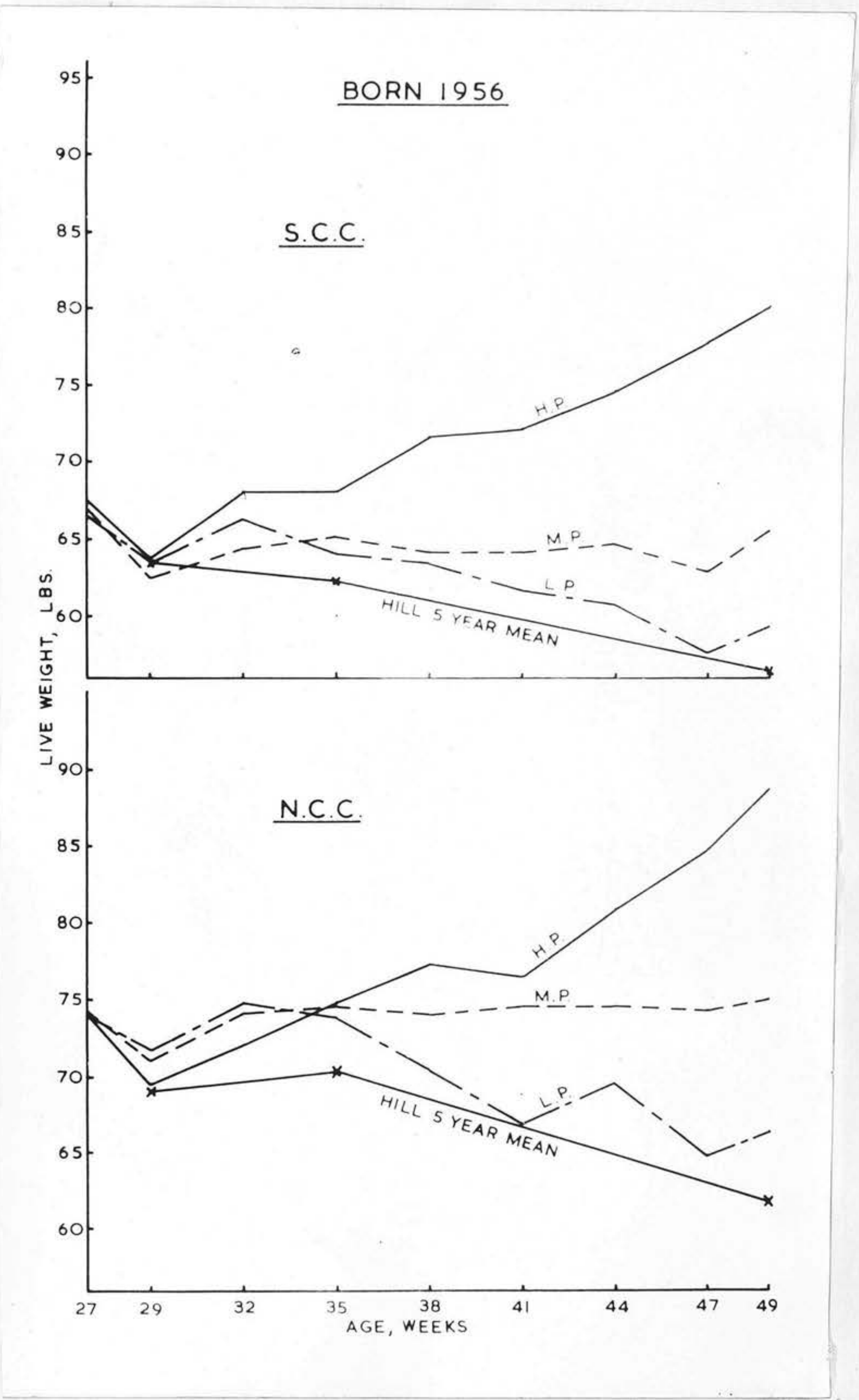

Fig. I. Live weight changes over treatment period.

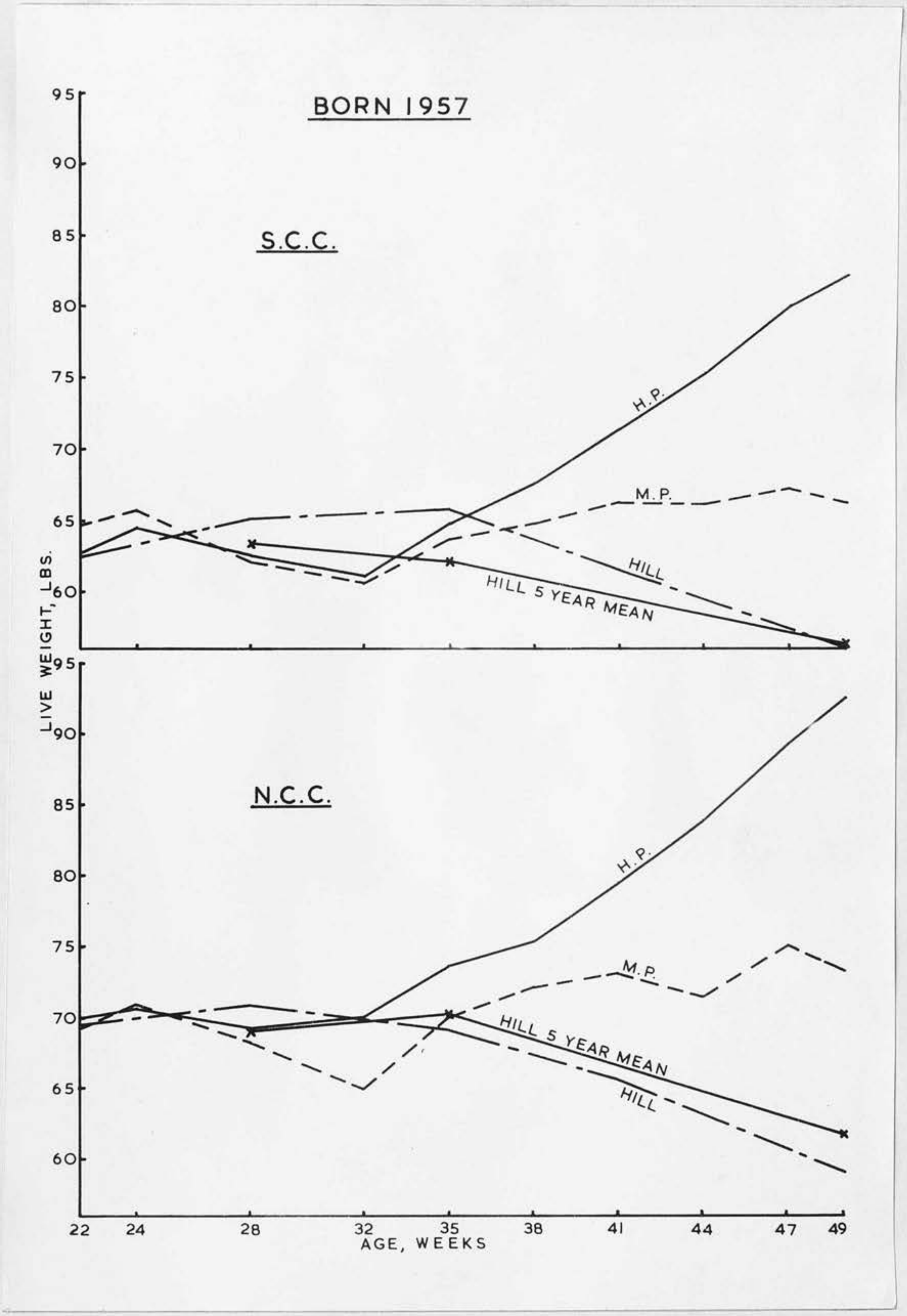

Fig. Ia. Live weight changes over treatment period.

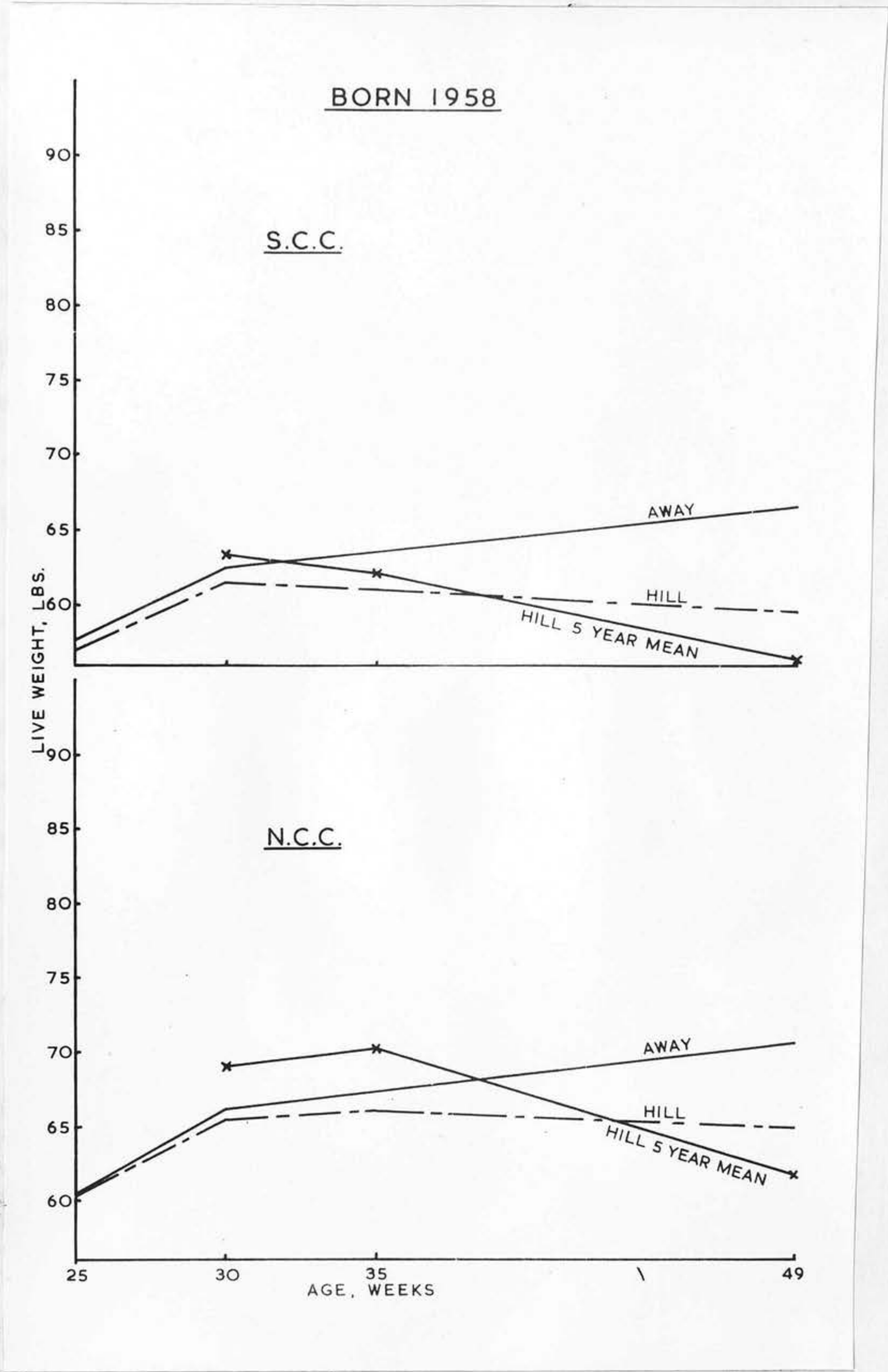

Fig. Ib. Live weight changes over treatment period.

and Method) with the L.P. groups following, if not quite achieving, the drop exhibited by the mean of five years pre-experimental hill wintering.

From Fig. I it can be seen that an initial drop in live weight occurred in all groups during the first two weeks of experimental feeding. This can be attributed to a reduction in gut-fill caused by the change in diet. On becoming acclimatised to the new diet a further 4 - 5 weeks were necessary before the different levels of feeding began to take effect. True divergence of the different groups only became apparent over the last 14 weeks of the treatment period, i.e. from the beginning of January onwards. Of the total changes in weight occurring between 1st November and 1st April, 95% of the H.P. gain in both breeds and 67% and 97% respectively of the S.C.C. and N.C.C. L.P. loss took place during the last 14 weeks, some 64% of the total treatment period (see Table 4).

Analysis of variance showed no significant differences between the group means at the start of the treatment period. Covariance analysis showed no significant differences in either breed between the group means at 35 weeks of age, after 8 weeks treatment. By 38 weeks, however, the S.C.C. H.P. group had become significantly heavier than both the M.P. and L.P. groups which did not differ significantly, while all three N.C.C. group differences had reached significance.

By the end of the treatment period, all groups within each breed differed significantly.

<u>Born 1957</u>. Over the treatment period of 27 weeks, the H.P. groups, S.C.C. and N.C.C. respectively, gained 19.6 lb. (31.3%) and 22.7 lb. (32.5%) over their initial weights; the M.P. groups both gained slightly, 1.7 lb. (2.6%) in the case of the S.C.C. and 4.1 lb. (5.9%) in the case of the N.C.C.; while the Hill groups lost 6.3 lb. (10.1%) and 10.3 lb. (14.8%) for S.C.C. and N.C.C. respectively.

With the feeding treatments starting 5 weeks earlier this year in an attempt

Table 3

Adjusted mean live weights and significance of differences between them over treatment period

Mean age in weeks		S.C.C.			N.C.C.		
				Born 1956			
		H.P.(13)+	M.P.(13)	L.P.(14)	H.P.(13)	M.P.(13)	L.P.(12)
35	H.P.	67.6			74.7		
	M.P.	NS	65.2		NS	74.4	
	L.P.	NS	NS	64.6	NS	NS	73.9
38	H.P.	71.3			77.3		
	M.P.	***	64.2		*	73.9	
	L.P.	***	NS	63.9	***	*	70.4
49	H.P.	80.0			88.7		
	M.P.	***	65.6		***	74.9	
	L.P.	***	*	59.6	***	***	66.4
				Born 1957			
		H.P.(13)	M.P.(12)	Hill(11)	H.P.(14)	M.P.(14)	Hill(14)
35	H.P.	65.3			73.4		
	M.P.	NS	62.6		*	70.1	
	Hill	NS	*	66.5	**	NS	69.2
41	H.P.	71.9			79.3		
	M.P.	***	65.3		***	73.2	
	Hill	***	NS	62.2	***	***	65.6
49	H.P.	83.0			92.4		
	M.P.	***	65.6		***	73.4	
	Hill	***	***	56.1	***	***	59.2
				Born 1958			
		Away(14)	Hill(13)		Away(15)	Hill(15)	
49	Away	66.5			70.4		
	Hill	***	59.9		**	64.8	

+Number of animals in brackets.
*** = Significant at the 0.1% level of probability.
** = " " " 1% " " "
* = " " " 5% " " "
NS = Non-significant.

Table 4

Percentage of total live weight gain occurring over last 14 weeks of treatment period

14 weeks as a %-age of total period	S.C.C.			N.C.C.		
	Born 1956					
	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.
63.6	95.3	-	- 66.7	95.2	-	-97.4
	Born 1957					
	H.P.	M.P.	Hill	H.P.	M.P.	Hill
51.9	89.3	-	-154.0	83.7	-	-97.1

to produce earlier, more extensive and more prolonged differences, it does appear from the above figures as if this had been achieved. However, examination of Fig. Ia shows a very similar pattern to that exhibited by the 1956 experimental groups in Fig. I. Being younger, the initial weights were some 5 lb. lighter than in 1956 and the drop experienced at the start of the experimental feeding in that year was not repeated. In both breeds, however, there was a tendency for the H.P. and M.P. groups after an initial rise in weight to lose their advantage and to fall off in weight slightly during the early winter, in spite of their very adequate feeding. In the Hill groups, uncomplicated by changes in diet or habitat, live weight continued to increase in the S.C.C. breed until the end of the year, while in the N.C.C. breed it dropped off slightly earlier, probably due to their larger size and greater maintenance requirements. As a result, in spite of the earlier commencement, divergence due to treatment did not become apparent until 35 weeks of age, as in the previous year. From this point on, the larger diets fed this year to the H.P. groups probably accounted for most of the greater increase in live weight compared with the 1956 born age group. An average winter gave average losses in the Hill groups with the larger N.C.C. animals suffering to a greater degree. In this year (Table 4), the last 14 weeks, or 52% of the total treatment period, accounted for 89% and 84% of the H.P. gain and 154% and 97% of the Hill group loss for S.C.C. and N.C.C. respectively from 26th September to 1st April.

Analysis of variance showed no significant differences between the group means at the start of the treatment period. At 35 weeks of age, after 13 weeks treatment, covariance analysis showed the S.C.C. Hill group to be significantly heavier than the M.P., due to the former's uncomplicated and continued live weight increase until the end of the year. Otherwise, in this breed, there were no significant differences between treatments at that time. In the N.C.C. breed at 35 weeks of age, the H.P. group had become

Erratum

Insert between last line on page 36 and first line on page 37.

.... significantly heavier than both the M.P. and Hill groups which did not differ significantly. Only in this breed has the earlier start to the treatments succeeded in creating significant differences of the intended nature, earlier than was the case with the previous age group.

By 41 weeks of age, the S.C.C. H.P. group had become ....

significantly heavier than both the M.P. and Hill groups while the difference existing between the latter two at 35 weeks had disappeared. All three N.C.C. group differences had reached significance by 41 weeks of age. By the end of the treatment period, all groups within each breed differed significantly.

Born 1958. Over the treatment period of 24 weeks, the Away wintered groups, S.C.C. and N.C.C. respectively, gained 9.1 lb. (15.8%) and 10.1 lb. (16.7%) over their initial weights, while the Hill groups gained 2.7 lb. (4.7%) and 4.5 lb. (7.5%). A severe spring and a dry summer resulted in small lambs of below average weight at the start of the treatment period. Following this, moderately good away wintering appeared to give a steady but slight increase in weight in the Away groups up till the 1st April (see Fig. Ib). However, no weight records were taken over the Away period and the live weight graph between 30 and 49 weeks may be anything but a straight line. A mild, open winter had little effect on the Hill groups, virtually maintaining them at the live weights reached by the middle of November and being nearer a M.P. treatment than a L.P.

Analysis of variance showed no significant differences between the group means at the start of the treatment period.

By the end of the treatment period, covariance analysis showed both Away groups to be significantly heavier than their respective Hill groups.

(b) Heavy and light hoggs prior to treatment. The actual mean live weights recorded over the treatment period in each experimental year are tabulated in Tables 5, 5a and 5b and illustrated in Figs. II, IIa and IIb. Total and percentage gains over the treatment period are shown in Table 6. Adjusted means from covariance analysis and the significance of differences between them for the heavy and light hoggs are shown in Tables 7, 7a and 7b.

Unlike the live weight changes for the total groups in section 1a above, which were the planned and direct measures of treatment, the live weight changes in the heavy and light hoggs are the nett result of these total group changes and while the composit picture which they produce has been predetermined, the

Table 5

Heavy and light hoggs prior to treatment.
Mean live weights over treatment period. (lb.)

Born 1956

Mean Age in weeks	S.C.C.						N.C.C.					
	H.P.		M.P.		L.P.		H.P.		M.P.		L.P.	
	Heavy	Light	Heavy	Light	Heavy	Light	Heavy	Light	Heavy	Light	Heavy	Light
27	74.4	59.5	72.8	62.3	71.4	60.0	80.6	69.9	82.0	69.2	79.2	70.3
29	69.6	57.0	67.0	58.7	66.4	59.7	73.8	66.9	77.4	67.0	76.0	68.6
32	73.3	62.0	69.5	60.0	69.5	62.0	77.6	68.8	82.0	69.1	78.0	72.6
35	72.3	62.8	70.7	60.6	67.4	59.8	80.2	71.3	81.4	70.1	78.0	70.9
38	75.7	67.0	69.5	59.7	66.1	60.0	83.4	73.4	80.4	70.0	74.4	67.4
41	76.4	67.2	70.0	59.1	64.3	58.3	82.8	72.4	80.2	71.0	70.8	63.9
44	78.9	69.8	70.2	60.0	62.8	58.0	85.8	77.6	80.0	71.0	73.8	66.4
47	82.0	73.0	68.5	58.1	59.3	55.3	90.2	81.4	78.2	71.8	68.8	61.9
49	84.3	75.5	70.7	61.3	60.1	58.2	94.2	85.2	77.2	73.6	70.8	63.1

Table 5a

Heavy and light hoggs prior to treatment.
Mean live weights over treatment period. (lb.)

Born 1957

Mean Age in weeks	S.C.C. H.P. Heavy	S.C.C. H.P. Light	S.C.C. M.P. Heavy	S.C.C. M.P. Light	S.C.C. Hill Heavy	S.C.C. Hill Light	N.C.C. H.P. Heavy	N.C.C. H.P. Light	N.C.C. M.P. Heavy	N.C.C. M.P. Light	N.C.C. Hill Heavy	N.C.C. Hill Light
22	67.5	55.0	70.2	60.9	67.0	56.0	75.0	66.1	73.4	63.7	74.2	65.9
24	68.9	57.6	69.6	62.9	-	-	74.8	67.5	74.1	66.7	-	-
28	66.6	56.2	65.0	60.0	69.3	59.2	73.7	65.9	70.7	64.8	74.3	68.1
32	64.5	55.6	64.8	57.6	-	-	71.1	65.8	66.8	63.0	-	-
35	67.9	60.0	68.4	60.3	69.7	60.4	77.3	70.9	72.5	66.5	71.7	67.2
38	70.1	63.8	70.4	60.9	-	-	77.8	73.5	74.4	69.2	-	-
41	74.0	67.4	71.8	62.4	64.7	57.2	81.7	77.9	75.4	70.0	67.3	64.2
44	77.5	72.0	72.0	62.0	-	-	85.7	82.6	73.4	68.8	-	-
47	82.1	77.0	74.2	62.4	-	-	90.7	88.3	76.9	72.7	-	-
49	84.3	79.2	73.2	61.4	58.3	52.3	94.3	91.3	75.1	70.8	59.0	59.3

Table 5b

Born 1958

	S.C.C. Away Heavy	S.C.C. Away Light	S.C.C. Hill Heavy	S.C.C. Hill Light	N.C.C. Away Heavy	N.C.C. Away Light	N.C.C. Hill Heavy	N.C.C. Hill Light
25	60.0	53.2	60.4	52.8	64.8	53.8	66.8	55.9
30	64.0	59.0	65.0	57.5	70.6	59.5	71.7	61.2
35	-	-	64.3	57.3	-	-	71.5	62.3
49	68.8	63.0	62.4	56.3	72.7	67.2	68.0	62.7

Table 6

Heavy and light hoggs prior to treatment.
Actual and percentage mean live weight gain over treatment period.

Born 1956

	S.C.C.						N.C.C.					
	H.P.		M.P.		L.P.		H.P.		M.P.		L.P.	
	Heavy	Light	Heavy	Light	Heavy	Light	Heavy	Light	Heavy	Light	Heavy	Light
Gain in lb. over 22 weeks	9.9	16.0	- 2.1	-1.0	-11.3	-1.8	13.6	15.3	-4.8	4.4	- 8.4	- 7.2
%-age gain	13.3	26.9	- 2.9	-1.6	-15.8	-3.0	16.9	21.9	-5.9	6.4	-10.6	-10.2

Born 1957

	S.C.C.						N.C.C.					
	H.P.		M.P.		Hill		H.P.		M.P.		Hill	
	Heavy	Light	Heavy	Light	Heavy	Light	Heavy	Light	Heavy	Light	Heavy	Light
Gain in lb. over 27 weeks	16.8	24.2	3.0	0.5	- 8.7	-3.7	19.3	25.2	1.7	7.1	-15.2	- 6.6
%-age gain	24.9	44.0	4.3	0.8	-13.0	-6.6	25.7	38.1	2.3	11.1	-20.5	-10.0

Born 1958

	S.C.C.				N.C.C.			
	Away		Hill		Away		Hill	
	Heavy	Light	Heavy	Light	Heavy	Light	Heavy	Light
Gain in lb. over 24 weeks	8.8	9.8	2.0	3.5	7.9	13.4	1.2	6.8
%-age gain	14.7	18.4	3.3	6.6	12.2	24.9	1.8	12.2

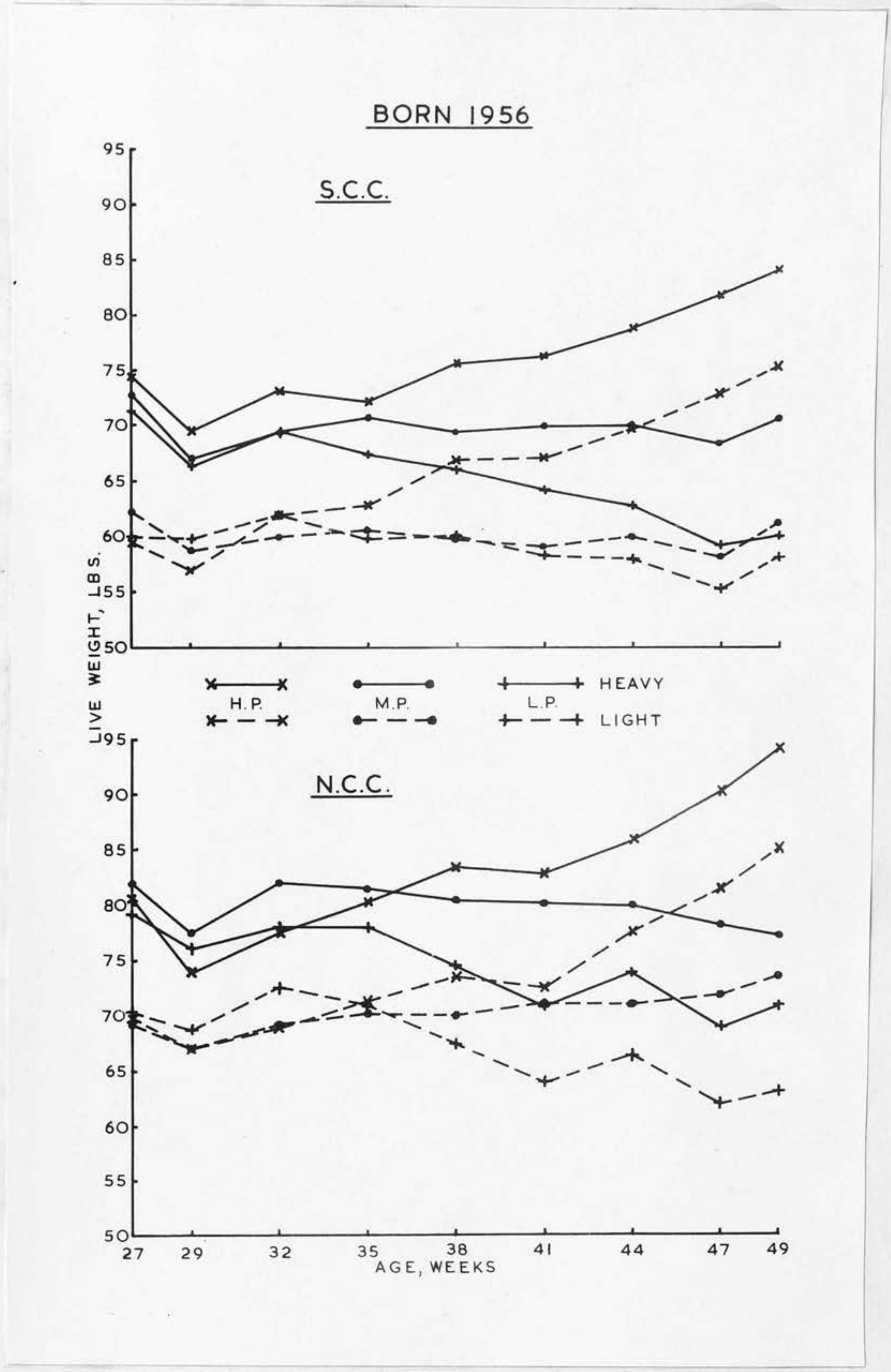

Fig. II. Live weight changes over treatment period of heavy and light hoggs prior to treatment.

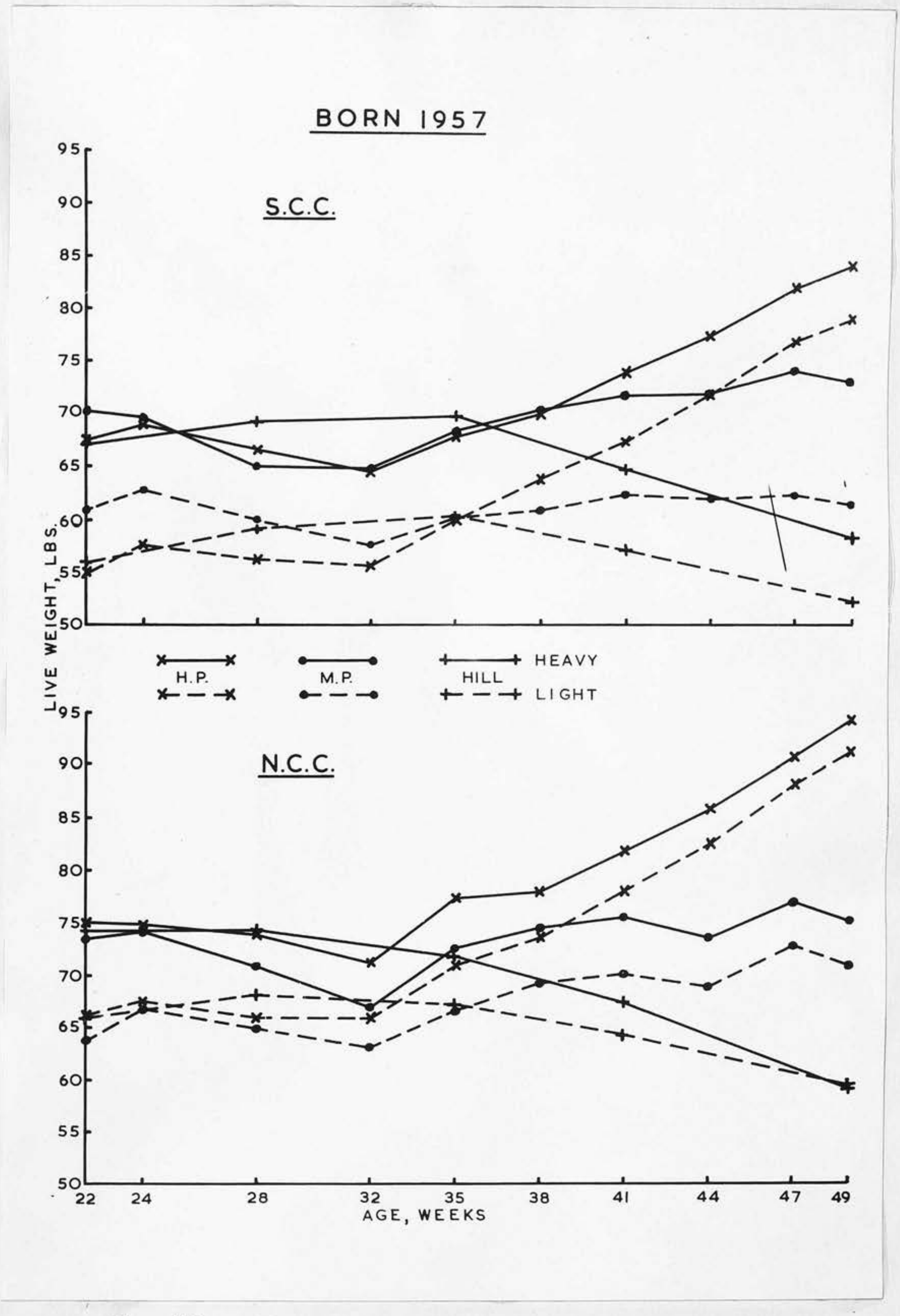

Fig. IIa. Live weight changes over treatment period of heavy and light hoggs prior to treatment.

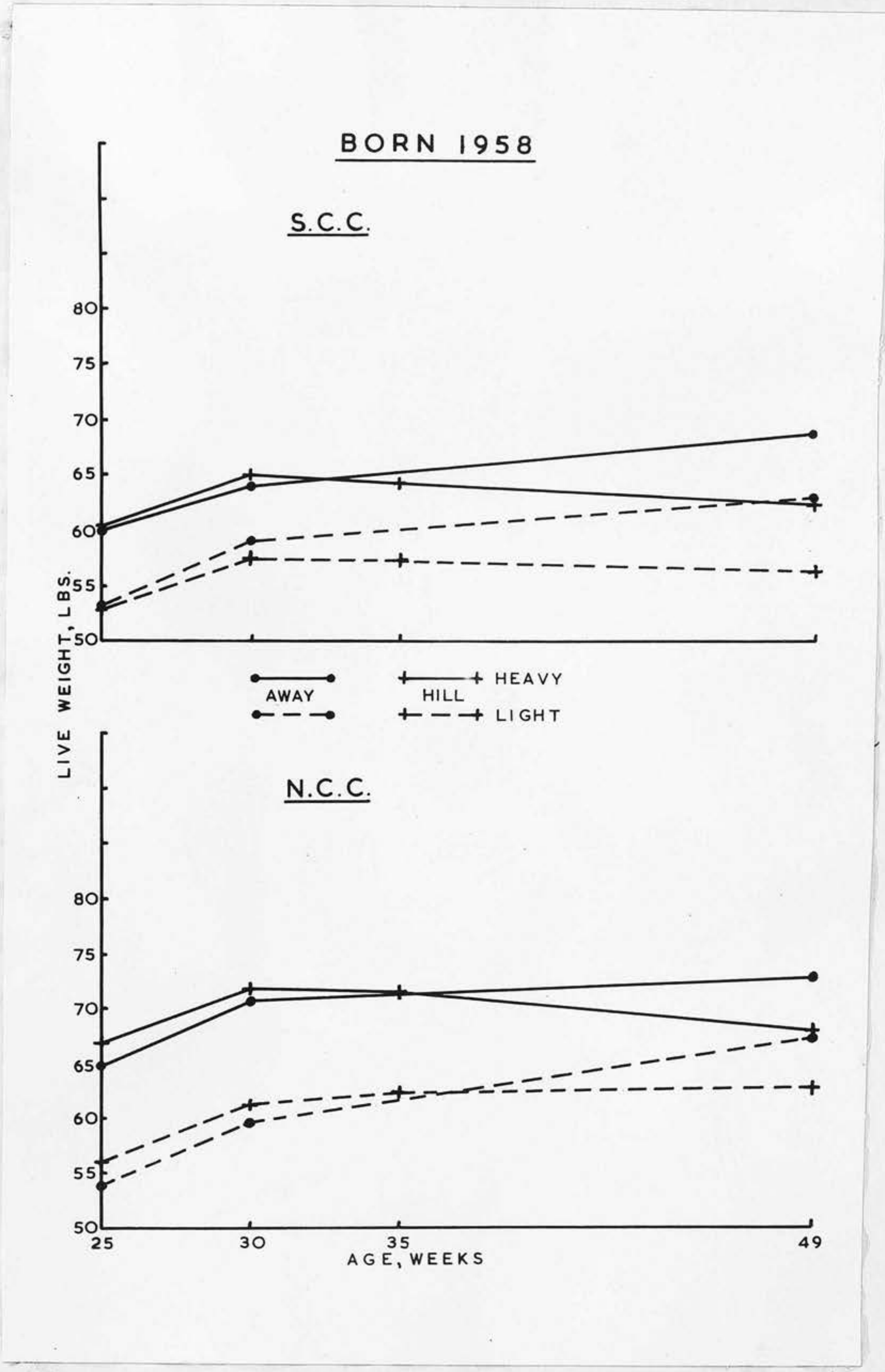

Fig. IIb. Live weight changes over treatment period of heavy and light hoggs prior to treatment.

relative changes of the heavy and light animals are the direct result of treatment complicated by unavoidable errors in technique of animal selection. This point is examined in greater detail in the discussion of results section.

Born 1956. Over the treatment period of 22 weeks, the H.P. light animals, S.C.C. and N.C.C. respectively, gained 16.0 lb. (26.9%) and 15.3 lb. (21.9%) compared with the smaller gains of the H.P. heavy animals, namely, 9.9 lb. (13.3%) and 13.6 lb. (16.9%). In the M.P. groups both heavy and light animals in the S.C.C. breed lost small amounts, 2.1 lb. (2.9%) and 1.0 lb. (1.6%) respectively, while in the N.C.C. breed the heavy animals lost 4.8 lb. (5.9%) and the light ones gained 4.4 lb. (6.4%). In the L.P. groups, the S.C.C. light animals lost very little weight, 1.8 lb. (3.0%), compared with the heavy animals which lost 11.3 lb. (15.8%). The N.C.C. L.P. heavy and light animals, however, both lost weight to approximately the same degree, namely, 8.4 lb. (10.6%) and 7.2 lb. (10.2%) respectively.

The live weight curves in Fig. II demonstrate the effects of treatment on the relative weights of the different sub-groups, a H.P. diet having made light animals heavier at 49 weeks than heavy animals on a M.P. diet, while a L.P. diet has made heavy animals lighter than light animals again on a M.P. diet.

Analysis of variance showed no significant differences between the heavy means nor between the light means at the start of the treatment period. Covariance analysis showed no significant differences in either breed between the heavy means nor between the light means at 35 weeks of age, after 8 weeks treatment. By 38 weeks, both the S.C.C. H.P. heavy and light sub-groups had become significantly heavier than their respective M.P. and L.P. sub-groups which in both weight classes did not differ significantly. In the N.C.C. breed, however, only between the H.P. and L.P. light sub-groups was there a significant difference. Differences were present between the heavy sub-groups but it was not possible to prove them significant, possibly due to the limited numbers and considerable within group variation. By the end of the treatment period, all

Table 7

Heavy and light hoggs prior to treatment. Adjusted mean live weights and significance of differences between them over treatment period.

Born 1956

Mean age in weeks		S.C.C. Heavy H.P.(7)+	S.C.C. Heavy M.P.(6)	S.C.C. Heavy L.P.(8)	S.C.C. Light H.P.(6)	S.C.C. Light M.P.(7)	S.C.C. Light L.P.(6)	N.C.C. Heavy H.P.(5)	N.C.C. Heavy M.P.(5)	N.C.C. Heavy L.P.(5)	N.C.C. Light H.P.(8)	N.C.C. Light M.P.(8)	N.C.C. Light L.P.(7)
35	(H.P.	70.8			63.7			80.2			71.2		
	(M.P.	NS	70.7		NS	59.4		NS	80.4		NS	70.6	
	(L.P.	NS	NS	68.7	NS	NS	60.3	NS	NS	79.0	NS	NS	70.4
38	(H.P.	74.3			67.9			83.4			73.3		
	(M.P.	*	69.5		*	58.5		NS	79.1		NS	70.3	
	(L.P.	*	NS	67.3	*	NS	60.5	NS	NS	75.7	*	NS	67.1
49	(H.P.	83.6			76.2			94.2			85.3		
	(M.P.	***	70.7		***	60.3		***	75.6		***	73.8	
	(L.P.	***	**	60.7	***	NS	58.6	***	NS	72.4	***	***	62.9

+Number of animals in brackets.
*** = Significant at the 0.1% level of probability.
** = " " " 1% " " "
* = " " " 5% " " "
NS = Non-significant.

Table 7a

Heavy and light hoggs prior to treatment. Adjusted mean live weights and significance of differences between them over treatment period.

Born 1957

Mean age in weeks		S.C.C. Heavy H.P.(8)+	S.C.C. Heavy M.P.(5)	S.C.C. Heavy Hill(7)	S.C.C. Light H.P.(5)	S.C.C. Light M.P.(7)	S.C.C. Light Hill(4)	N.C.C. Heavy H.P.(6)	N.C.C. Heavy M.P.(8)	N.C.C. Heavy Hill(6)	N.C.C. Light H.P.(8)	N.C.C. Light M.P.(6)	N.C.C. Light Hill(8)
35	(H.P.	68.3			61.8			76.6			70.6		
	(M.P.	NS	66.3		NS	58.1		NS	73.1		NS	67.3	
	(Hill	NS	NS	70.7	NS	NS	61.4	NS	NS	71.6	NS	NS	67.1
41	(H.P.	74.4			68.7			81.1			77.7		
	(M.P.	NS	69.6		*	60.9		NS	75.9		***	70.5	
	(Hill	**	NS	65.8	**	NS	57.9	***	**	67.2	***	**	64.1
49	(H.P.	84.8			81.3			93.7			90.9		
	(M.P.	***	70.8		***	59.7		***	75.6		***	71.7	
	(Hill	***	**	59.4	***	NS	52.6	***	***	58.9	***	**	59.0

+Number of animals in brackets.
*** = Significant at the 0.1% level of probability.
** = " " " 1% " " "
* = " " " 5% " " "
NS = Non-significant.

Table 7b

Heavy and light hoggs prior to treatment. Adjusted mean live weights and significance of differences between them over treatment period.

Mean age in weeks		S.C.C. Heavy Away(9)+	S.C.C. Heavy Hill(7)	S.C.C. Light Away(5)	S.C.C. Light Hill(6)	N.C.C. Heavy Away(9)	N.C.C. Heavy Hill(6)	N.C.C. Light Away(6)	N.C.C. Light Hill(9)
49	(Away	68.9		62.9		73.4	–	68.5	
	(Hill	**	62.3	**	56.4	*	67.0	**	61.9

Born 1958

+Number of animals in brackets.
** = Significant at the 1% level of probability.
* = " " " 5% " " "

the S.C.C. heavy sub-groups and the N.C.C. light sub-groups differed significantly from one another within their own weight class. In the S.C.C. light and N.C.C. heavy weight classes, however, the M.P. and L.P. sub-groups, although both significantly lighter than their respective H.P. sub-groups, did not themselves differ significantly.

Born 1957. Over the treatment period of 27 weeks, the H.P. light animals, S.C.C. and N.C.C. respectively, gained 24.2 lb. (44.0%) and 25.2 lb. (38.1%) compared with the smaller gains of the H.P. heavy animals, namely 16.8 lb. (24.9%) and 19.3 lb. (25.7%). In the N.C.C. M.P. group, the light animals gained 7.1 lb. (11.1%) while the heavy animals only gained 1.7 lb. (2.3%), but in the S.C.C. M.P. group, the light animals only gained 0.5 lb. (0.8%) while the heavy animals gained 3.0 lb. (4.3%). In the Hill groups, the heavy animals of both breeds, S.C.C. and N.C.C. respectively, lost more weight, 8.7 lb. (13.0%) and 15.2 lb. (20.5%), than the respective light animals which lost only 3.7 lb. (6.6%) and 6.6 lb. (10.0%).

The effects of treatment on the relative weights of the different sub-groups are demonstrated in Fig. IIa. The gradation at 49 weeks from the H.P. heavy down through the sub-groups to the Hill light is even more striking than in 1956, particularly in the N.C.C. breed, where the convergence of the Hill weight classes is another point of interest.

Analysis of variance showed no significant differences between the heavy means in either breed, nor between the N.C.C. light means at the start of the treatment period. Significance did, however, exist between the S.C.C. light means at this time. Covariance analysis showed no significant differences in either breed between the heavy means nor between the light means at 35 weeks of age after 13 weeks treatment. By 41 weeks, both the S.C.C. H.P. heavy and light sub-groups had become significantly heavier than their respective Hill sub-group and the H.P. light animals were also significantly heavier than the M.P. light. No other sub-groups within each weight class differed significantly in this breed at this time. In the N.C.C. heavy weight class at 41 weeks, the Hill animals had become significantly lighter than both the H.P. and M.P. animals which did not differ significantly while in the N.C.C. light weight class, all three sub-group differences had become significant.

By the end of the treatment period, all three sub-groups in both N.C.C. weight classes and the S.C.C. heavy weight class differed significantly, while in the S.C.C. light weight class, the M.P. and Hill sub-groups, although both significantly lighter than the H.P. sub-group, did not themselves differ significantly.

Born 1958. Over the treatment period of 24 weeks, the Away wintered light animals, S.C.C. and N.C.C. respectively, gained 9.8 lb. (18.4%) and 13.4 lb. (24.9%) compared with the smaller gains of the Away wintered heavy animals, namely 8.8 lb. (14.7%) and 7.9 lb. (12.2%). The same relative response occurred with less magnitude in the Hill wintered groups, the light animals, S.C.C. and N.C.C. respectively, gaining 3.5 lb. (6.6%) and 6.8 lb. (12.2%) compared with 2.0 lb. (3.3%) and 1.2 lb. (1.8%) for the heavy animals. Fig. IIb illustrates the ability of Away wintering to make light animals as heavy at 49 weeks as Hill wintered heavy ones, even in a mild, open winter.

Analysis of variance showed no significant differences between the heavy means nor between the light means at the start of the treatment period. By the end of the treatment period, covariance analysis showed the Away wintered animals in both weight classes in both breeds to be significantly heavier than those in the corresponding Hill groups.

2. Summer after treatment, 12 - 18 months

(a) Total groups. The actual mean live weights recorded over the summer after treatment in each experimental year are shown in Table 8 and illustrated in Figs. III, IIIa and IIIb. Adjusted means from covariance analysis and the significance of differences between them are shown in Tables 9, 9a and 9b. Photographs of the 1957 born treatment groups at 18 months are shown in Plates 5

Table 8

Mean live weights over summer after treatment, 12 - 18 months (lbs.)

Born 1956

Mean Age in weeks	S.C.C. Pre-experiment records*	S.C.C. H.P.	S.C.C. M.P.	S.C.C. L.P.	N.C.C. Pre-experiment records*	N.C.C. H.P.	N.C.C. M.P.	N.C.C. L.P.
49	56.4	80.2	65.6	59.3	61.7	88.7	75.0	66.3
57	68.0	89.2	74.9	72.1	75.6	100.1	90.2	81.8
67	83.2[+]	95.9	84.0	82.9	93.1[+]	106.0	100.7	92.5
73		96.4	84.5	83.9		106.4	102.8	94.0
80	92.6	102.8	91.5	92.6	102.5	110.8	110.0	99.7

Born 1957

Mean Age in weeks	S.C.C. Pre-experiment records*	S.C.C. H.P.	S.C.C. M.P.	S.C.C. Hill	N.C.C. Pre-experiment records*	N.C.C. H.P.	N.C.C. M.P.	N.C.C. Hill
49	56.4	82.3	66.3	56.1	61.7	92.6	73.3	59.1
57	68.0	83.1	76.1	69.1	75.6	93.0	82.5	72.8
68	83.2[+]	91.2	87.1	79.4	93.1[+]	99.5	92.8	83.2
79	92.6	101.3	97.8	89.2	102.5	109.3	104.0	93.5

Born 1958

Mean Age in weeks	S.C.C. Pre-experiment records*	S.C.C. Away	S.C.C. Hill	N.C.C. Pre-experiment records*	N.C.C. Away	N.C.C. Hill
49	56.4	66.7	59.6	61.7	70.5	64.8
57	68.0	82.5	75.8	75.6	87.5	81.3
68	83.2[+]	94.9	88.9	93.1[+]	102.7	96.2
82	92.6	101.6	97.7	102.5	111.0	107.1

* Mean of 5 years' records.

\+ " " 3 " " only.

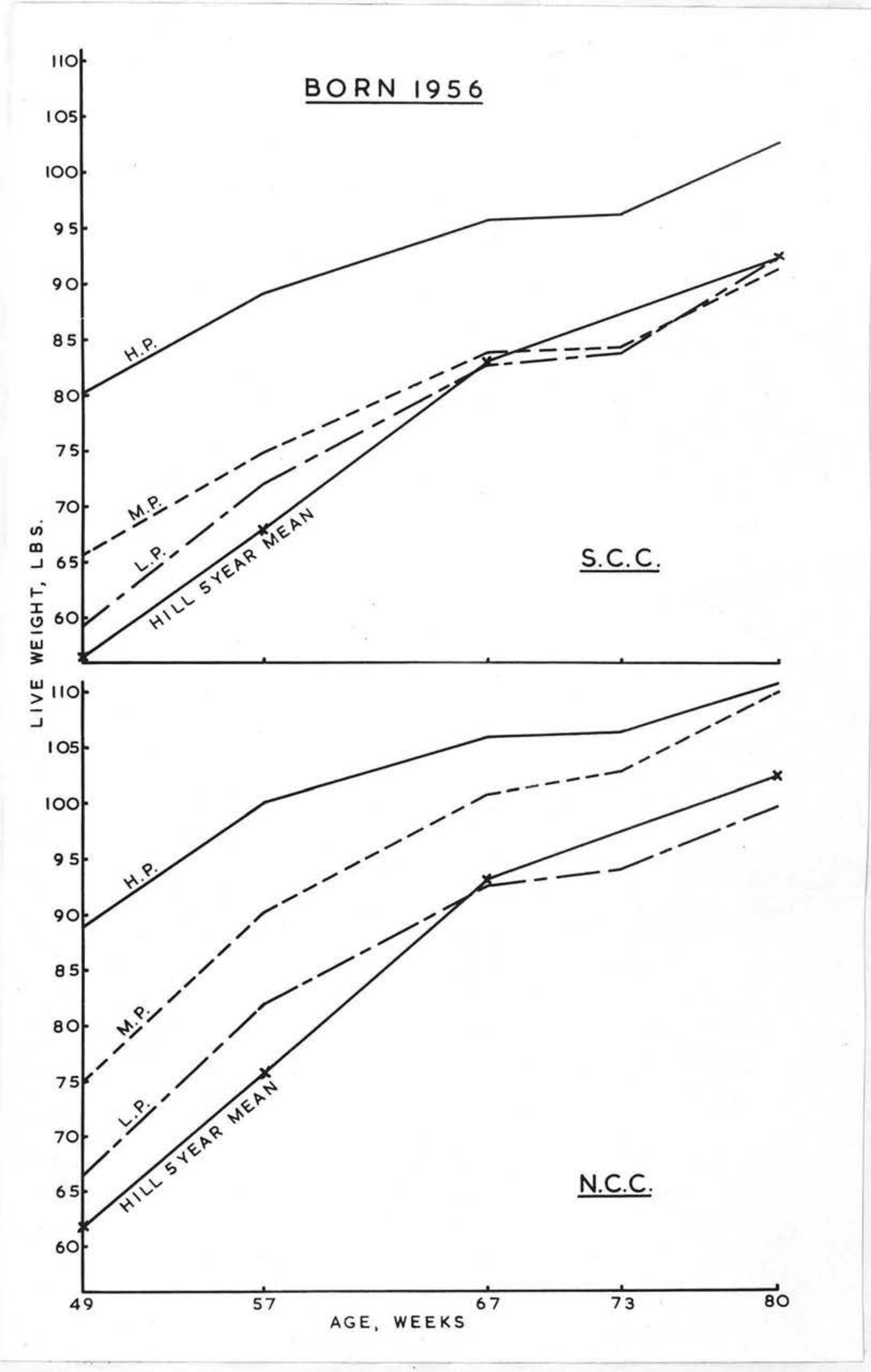

Fig. III. Live weight changes over the summer after treatment.

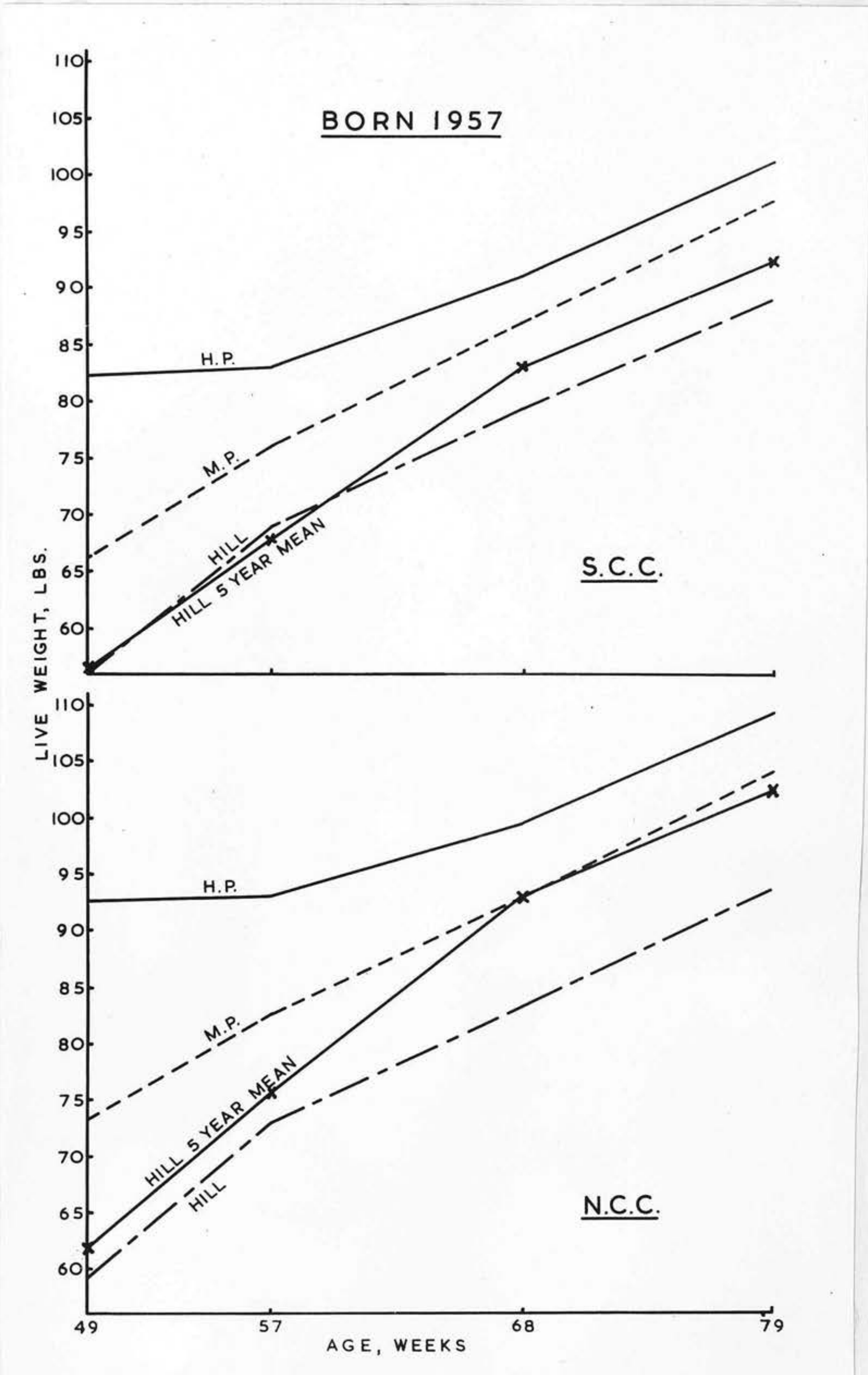

Fig. IIIa. Live weight changes over the summer after treatment.

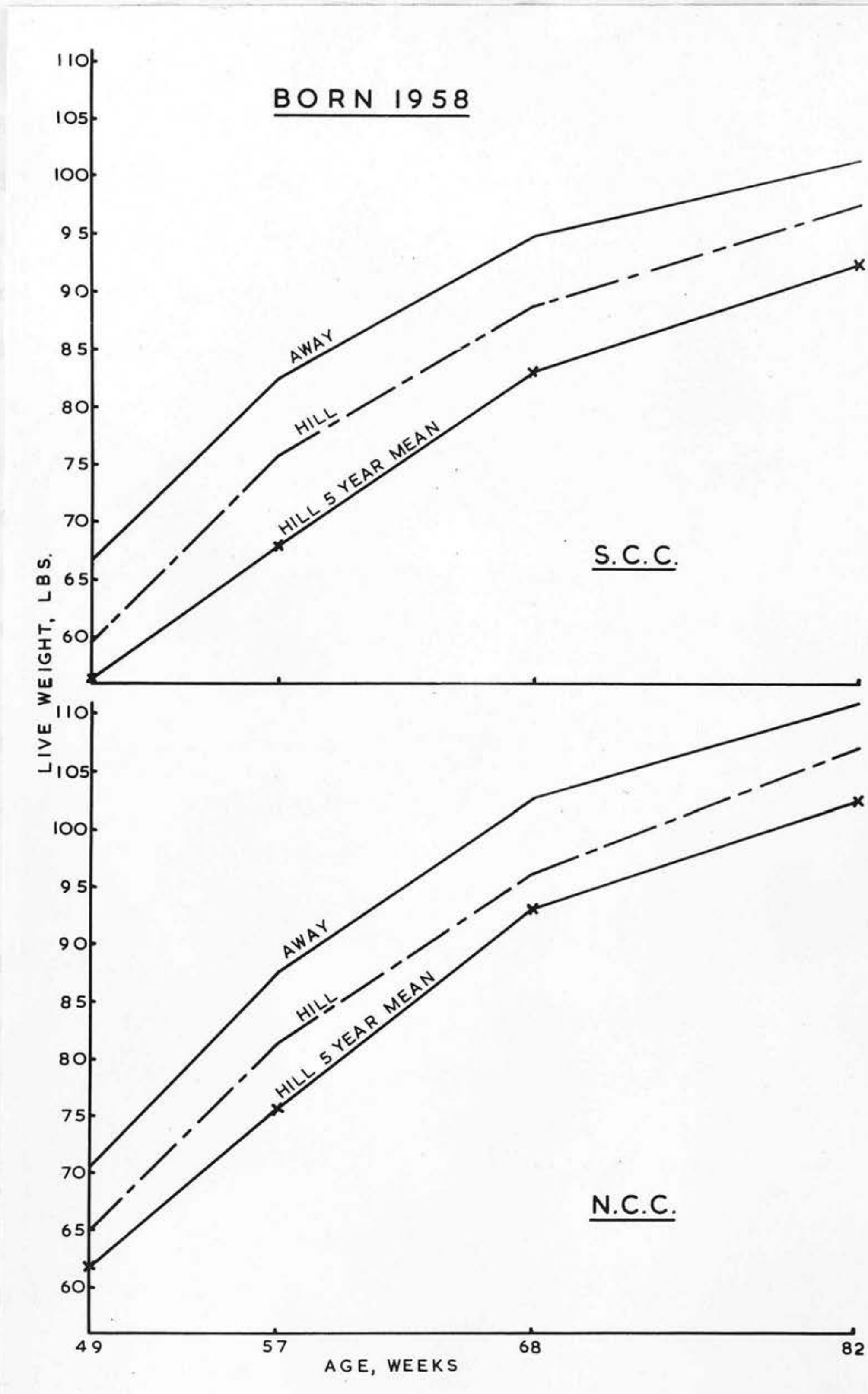

Fig. IIIb. Live weight changes over the summer after treatment.

and 6. Unfortunately, no photographic record of the 1956 born groups is available.

<u>Born 1956</u>. Having achieved by the end of the treatment period at 49 weeks very considerable differences in mean live weights between treatments in both breeds, the hoggs were then summered on the hill with the main flock under identical conditions. Over this period of 31 weeks, the H.P. groups, S.C.C. and N.C.C. respectively, gained a further 22.6 lb. (28.2%) and 22.1 lb. (24.9%) over their weights at the end of the treatment period; the M.P. groups gained 25.9 lb. (39.5%) and 35.0 lb. (46.7%); while the L.P. groups gained 33.3 lb. (56.2%) and 33.4 lb. (50.4%).

All three treatment groups in both breeds showed very similar and rapid increases in weight during the first 8 - 10 weeks after being returned to the hill, roughly half the total increase in weight over the whole period occurring during that time, being April - May. Thereafter, increase in live weight slowed relatively in all groups but particularly so in both H.P. groups and the S.C.C. M.P. As a result the differences present between the H.P. and L.P. groups at 49 weeks of 20 lb. and 22 lb., in S.C.C. and N.C.C. respectively, had diminished by 80 weeks to 10 lb. and 11 lb. The M.P. groups made very different responses to the summer environment in terms of live weight increase, that in the S.C.C. breed slowing up so much as to end up at the same level as the L.P. group while that in the N.C.C. breed increasing so much that by the end of the period it was level with the H.P. group.

Both L.P. groups followed quite closely the five year mean of pre-experimental weights which suggests that the summer of 1957 was approximately average, though from Fig. III it would appear that the spring and early summer may have been above average and late summer and autumn below average. The early picture may, however, only be due to the slightly better condition of the experimental L.P. hoggs at the end of the treatment period.

By covariance analysis, all groups in both breeds were shown to be

Table 9

Adjusted mean live weights and significance of differences between them over summer after treatment, 12 - 18 months

Born 1956

Mean age in weeks		S.C.C. H.P.	S.C.C. M.P.	S.C.C. L.P.	N.C.C. H.P.	N.C.C. M.P.	N.C.C. L.P.
49	(H.P.	80.0(13)[+]			88.7(13)		
	(M.P.	***	65.6(13)		***	74.9(13)	
	(L.P.	***	*	59.6(14)	***	***	66.4(12)
57	(H.P.	89.0(10)			100.1(12)		
	(M.P.	***	75.6(11)		**	90.0(12)	
	(L.P.	***	NS	71.7(12)	***	**	82.0(11)
67	(H.P.	95.7			106.1		
	(M.P.	***	84.5		*	100.5	
	(L.P.	***	NS	82.6	***	**	92.7
80	(H.P.	102.6			110.9		
	(M.P.	***	92.1		NS	109.6	
	(L.P.	***	NS	92.3	**	**	100.0

+ Number of animals in brackets.
*** = Significant at the 0.1% level of probability.
** = " " " 1% " " "
* = " " " 5% " " "
NS = Non-significant.

Table 9a

Adjusted mean live weights and significance of differences between them over summer after treatment, 12 - 18 months

Born 1957

Mean age in weeks		S.C.C. H.P.	S.C.C. M.P.	S.C.C. Hill	N.C.C. H.P.	N.C.C. M.P.	N.C.C. Hill
49	(H.P.	83.0(13)[+]			92.4(14)		
	(M.P.	***	65.6(12)		***	73.4(14)	
	(Hill	***	***	56.1(11)	***	***	59.2(14)
57	(H.P.	83.9(12)			92.9(13)		
	(M.P.	***	74.7(9)		**	82.6(13)	
	(Hill	***	*	69.3(10)	***	**	72.8(13)
68	(H.P.	91.7			99.4		
	(M.P.	*	85.9		**	93.0	
	(Hill	***	*	79.9	***	***	83.2
79	(H.P.	101.9(11)			109.2		
	(M.P.	NS	96.4		NS	104.1	
	(Hill	**	NS	89.8	***	**	93.6

+ Number of animals in brackets.
*** = Significant at the 0.1% level of probability.
** = " " " 1% " " "
* = " " " 5% " " "
NS = Non-significant.

Table 9b

Adjusted mean live weights and significance of differences between them over summer after treatment, 12 - 18 months

Born 1958

Mean age in weeks		S.C.C. Away	S.C.C. Hill	N.C.C. Away	N.C.C. Hill
49	(Away	66.5(14)+		70.4(15)	
	(Hill	***	59.9(13)	**	64.8(15)
57	(Away	82.3		87.4	
	(Hill	*	76.0	**	81.3
68	(Away	94.8(13)		102.7	
	(Hill	NS	89.0	*	96.2
82	(Away	101.5		111.0	
	(Hill	NS	97.9	NS	107.2

+ Number of animals in brackets.
*** = Significant at the 0.1% level of probability.
** = " " " 1% " " "
* = " " " 5% " " "
NS = Non-significant.

significantly different in live weight at the end of the treatment period at 49 weeks. By 57 weeks the difference between the S.C.C. M.P. and L.P. groups was no longer significant and by 80 weeks it had completely disappeared. The S.C.C. H.P. group was significantly heavier than the other two groups throughout the summer and was still so at 80 weeks in spite of the reduced difference. In the N.C.C. breed, all groups differed significantly up till 67 weeks but by 80 weeks, the difference between the H.P. and M.P. groups was no longer significant. Both these groups, however, were still significantly heavier than the L.P. at 80 weeks.

Born 1957. Over the summer after treatment, a period of 30 weeks this year, the H.P. groups, S.C.C. and N.C.C. respectively, gained a further 19.0 lb. (23.1%) and 16.7 lb. (18.0%) over their weights at the end of the treatment period; the M.P. groups gained 31.5 lb. (47.5%) and 30.7 lb. (41.9%); while the Hill groups gained 33.1 lb. (59.0%) and 34.4 lb. (58.2%).

In this year, the immediate response to the hill environment took a different form from that of the 1956 born animals. Both H.P. groups gained virtually nothing between 49 and 57 weeks and while the M.P. and Hill groups did put on weight, they did so at a much slower rate over this period than was the case with the previous age group. The principle factor causing this was undoubtedly the very severe, late spring of this year, 1958, which resulted in a considerable check to the H.P. groups. The greater condition of the H.P. animals in this year, as a result of the bigger diet fed, in particular the N.C.C. H.P., was another factor complementary to the above picture. Having fed these animals very well all winter their growth was well advanced and a certain amount of fat had also been laid down. On their return to the hill, the change both in quality and quantity of their diet probably caused a considerable drop in live weight, largely of gut fill, during the first few weeks, which had been overcome by 57 weeks giving an apparently level weight curve, Fig. IIIa. The change in diet may also have affected the M.P. groups, a fact that probably accounts for most of the difference in relative live weight increase between these and the Hill groups during the first few weeks, the latter not being subjected to any change in diet or environment.

After this rapid initial reduction in live weight differences between 49 and 57 weeks, the relative rates of increase levelled off with the H.P. groups gradually attaining very similar rates as the other treatment groups. In the M.P. and Hill groups from 57 weeks onwards the rate of increase was almost identical, with the latter groups being just a fraction slower. The differences of 26 lb. and 33 lb., in S.C.C. and N.C.C. respectively, between the H.P. and Hill groups at 49 weeks had diminished by 79 weeks to 12 lb. and 16 lb., while the respective differences between the M.P. and Hill groups of 10 lb. and 14 lb. which had shrunk to 7 lb. and 10 lb. by 57 weeks, increased slightly to 9 lb. and 11 lb. by 79 weeks.

That the spring and summer of 1958 were below average has been mentioned above. Fig. IIIa demonstrates this very well, the Hill groups dropping below the mean of five years pre-experimental weights, particularly the N.C.C. Hill animals, which probably suffered more in a hard season on account of their greater size. This also probably explains the general lowering of all three N.C.C. groups, the M.P. animals closely approximating to the pre-experimental mean towards the end of the summer.

By covariance analysis, all groups in both breeds were shown to be significantly different in live weight at the end of the treatment period at 49 weeks. In both breeds, all groups differed significantly up till 68 weeks. In the S.C.C. breed by 79 weeks, the differences between the H.P. and M.P. groups and the M.P. and Hill groups were no longer significant, in the latter case due to increased within group variability in spite of increased difference. The difference between the H.P. and Hill groups was still significant at this time. In the N.C.C. breed by 79 weeks, the difference between the H.P. and M.P. groups was no longer significant but both these groups remained significantly heavier than the Hill group.

Born 1958. Over the summer after treatment, a period of 33 weeks this year, the Away groups, S.C.C. and N.C.C. respectively, gained 34.9 lb. (52.3%) and 40.5 lb. (57.4%) over their weights at the end of the treatment period, while the Hill groups gained 38.1 lb. (63.9%) and 42.3 lb. (65.3%).

In this year, after a mild, open winter and moderate Away wintering, live weight in both treatment groups in both breeds increased very rapidly over the first eight weeks and at the same rate. After 57 weeks the rate of increase slowed up though still remaining the same in both treatment groups. Only towards the end of the summer period did the relative rates alter, the Away groups gaining at an even slower rate than the Hill. With no complications of changes from dry to wet diets and an open winter and early spring, the response after the treatment period in live weight increase was this year the most rapid of the three years experiments. The 7 lb. and 6 lb. differences existing between treatments at 49 weeks in S.C.C. and N.C.C. respectively, while virtually still there at 68 weeks, had diminished by 82 weeks to 4 lb. in both cases.

The above average summer in 1959 is demonstrated in Fig. IIIb, where in both breeds, both treatment groups remained consistently and considerably higher than the mean of five years pre-experimental weights.

By covariance analysis, the difference between the treatments in each breed has been shown to be significant at 49 weeks. The difference in both breeds remained significant at 57 weeks. By 68 weeks only the difference between the N.C.C. treatments was still significant, that in the S.C.C. breed having ceased to be so. No significant difference existed in either breed between treatments at the end of the summer period at 82 weeks.

(b) Heavy and light hoggs prior to treatment. The actual mean live weights recorded over the summer after treatment in each experimental year are shown in Table 10 and illustrated in Figs. IV, IVa and IVb. Adjusted means from covariance analysis and the significance of differences between them for the heavy and light hoggs are shown in Tables 11, 11a and 11b.

Table 10

Heavy and light hoggs prior to treatment.
Mean live weights over summer after treatment, 12 - 18 months (lbs.)

Born 1956

Mean Age in weeks	S.C.C. H.P. Heavy	S.C.C. H.P. Light	S.C.C. M.P. Heavy	S.C.C. M.P. Light	S.C.C. L.P. Heavy	S.C.C. L.P. Light	N.C.C. H.P. Heavy	N.C.C. H.P. Light	N.C.C. M.P. Heavy	N.C.C. M.P. Light	N.C.C. L.P. Heavy	N.C.C. L.P. Light
49	84.3	75.5	70.7	61.3	60.1	58.2	94.2	85.2	77.2	73.6	70.8	63.1
57	92.8	85.6	81.3	71.3	72.9	70.5	105.2	96.4	90.2	90.1	89.6	75.3
67	99.0	92.8	88.7	81.3	83.5	81.7	113.2	100.9	102.6	99.3	101.6	85.0
73	99.4	93.4	89.8	81.6	85.3	81.3	112.8	101.9	104.2	101.9	103.8	85.8
80	105.2	100.4	96.5	88.7	93.9	90.0	118.0	105.6	112.2	108.4	109.4	91.7

Born 1957

Mean Age in weeks	S.C.C. H.P. Heavy	S.C.C. H.P. Light	S.C.C. M.P. Heavy	S.C.C. M.P. Light	S.C.C. Hill Heavy	S.C.C. Hill Light	N.C.C. H.P. Heavy	N.C.C. H.P. Light	N.C.C. M.P. Heavy	N.C.C. M.P. Light	N.C.C. Hill Heavy	N.C.C. Hill Light
49	84.3	79.2	73.2	61.4	58.3	52.3	94.3	91.3	75.1	70.8	59.0	59.3
57	86.0	79.0	81.5	71.8	73.7	62.3	94.5	91.7	84.6	79.0	72.0	73.4
68	93.4	87.3	92.3	83.0	83.5	73.3	103.0	96.6	93.6	91.6	83.5	82.9
79	103.9	96.8	103.8	93.0	95.7	79.5	113.8	105.4	104.4	103.4	93.0	94.0

Born 1958

Mean Age in weeks	S.C.C. Away Heavy	S.C.C. Away Light	S.C.C. Hill Heavy	S.C.C. Hill Light	N.C.C. Away Heavy	N.C.C. Away Light	N.C.C. Hill Heavy	N.C.C. Hill Light
49	68.8	63.0	62.4	56.3	72.7	67.2	68.0	62.7
57	83.9	80.2	79.0	72.0	89.2	84.8	84.0	79.4
68	96.0	93.2	91.6	85.8	104.6	100.0	97.3	95.4
82	104.0	97.8	100.7	94.2	112.4	108.8	109.3	105.7

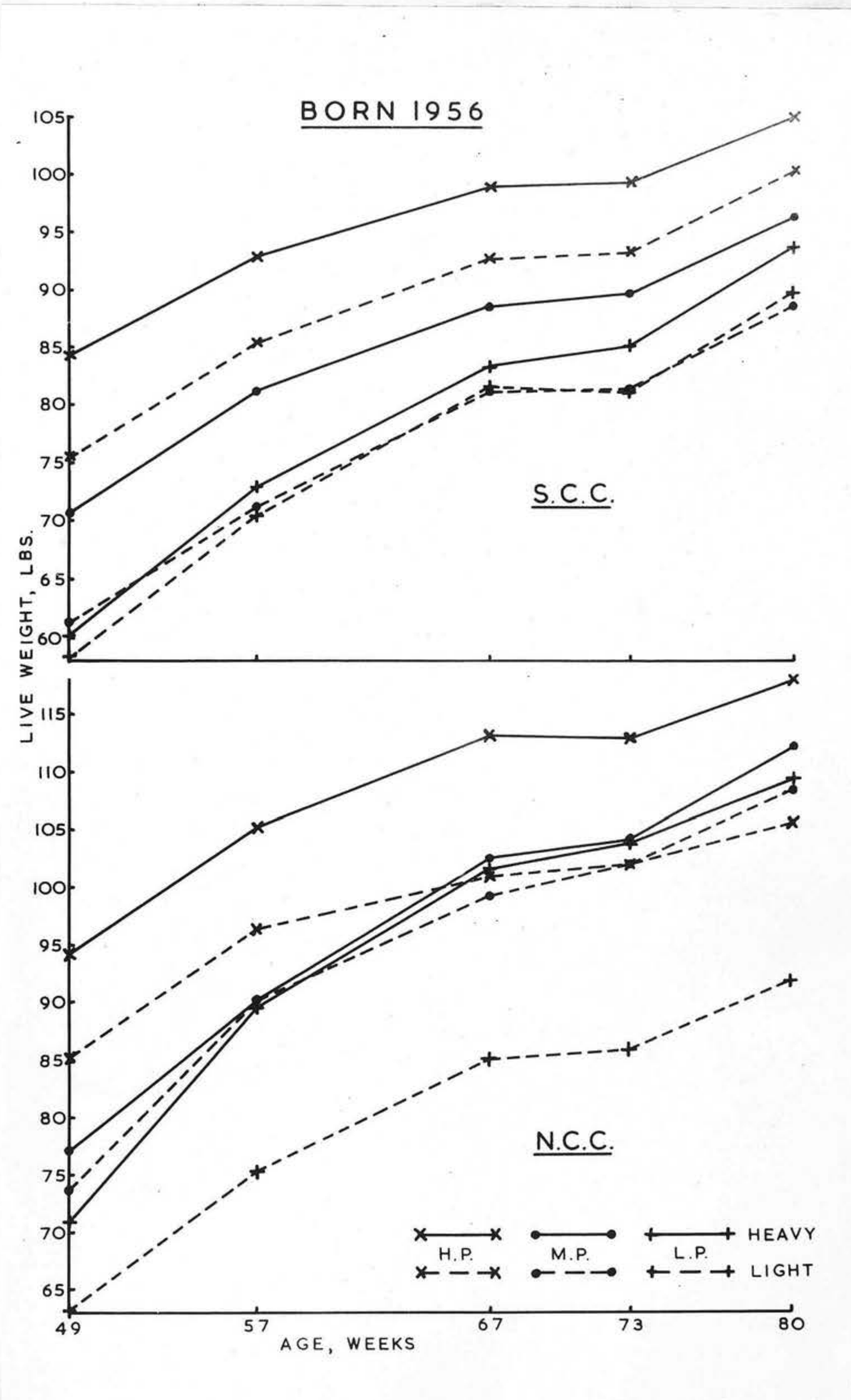

Fig. IV. Live weight changes over the summer after treatment of heavy and light hoggs prior to treatment.

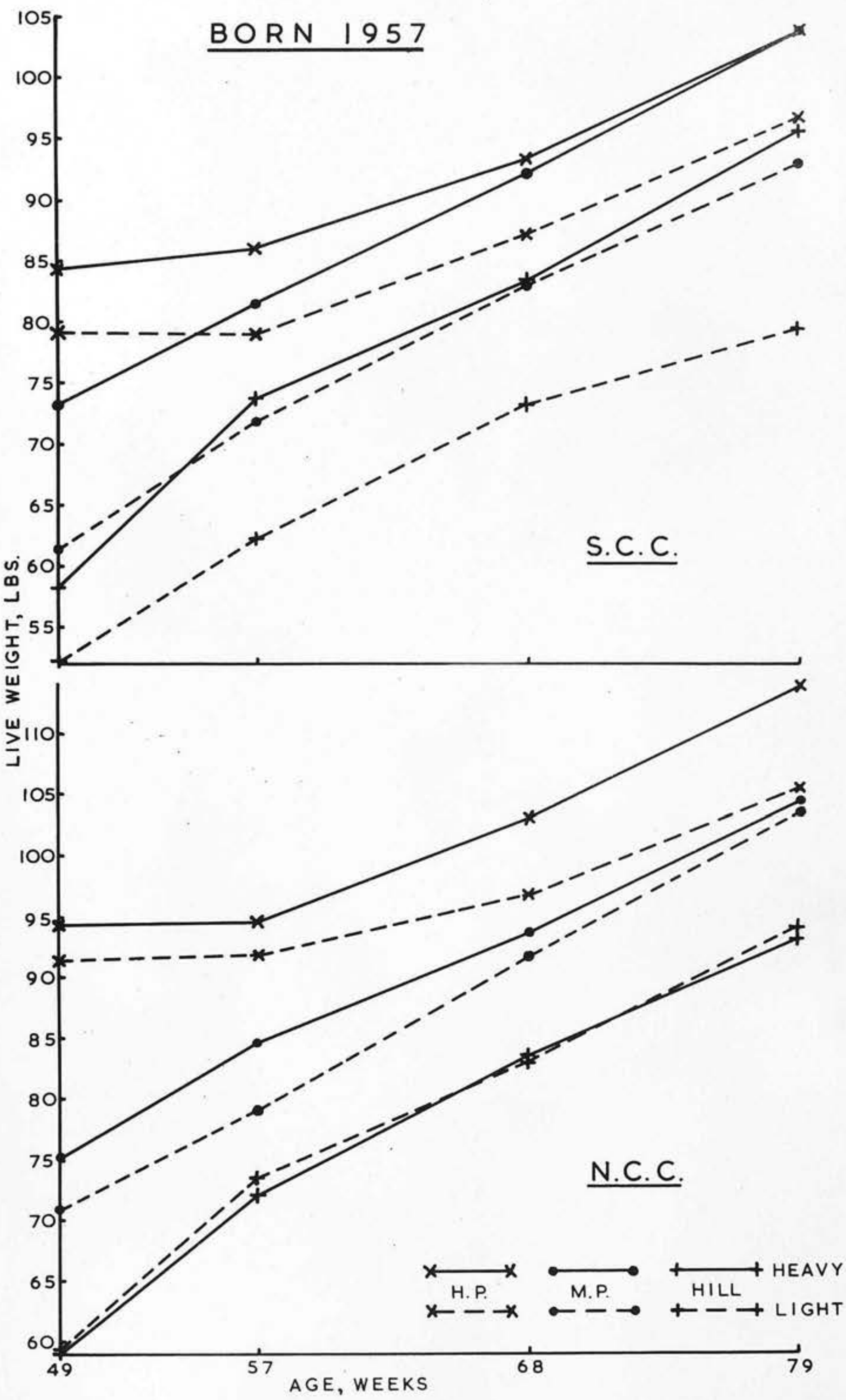

Fig. IVa. Live weight changes over the summer after treatment of heavy and light hoggs prior to treatment.

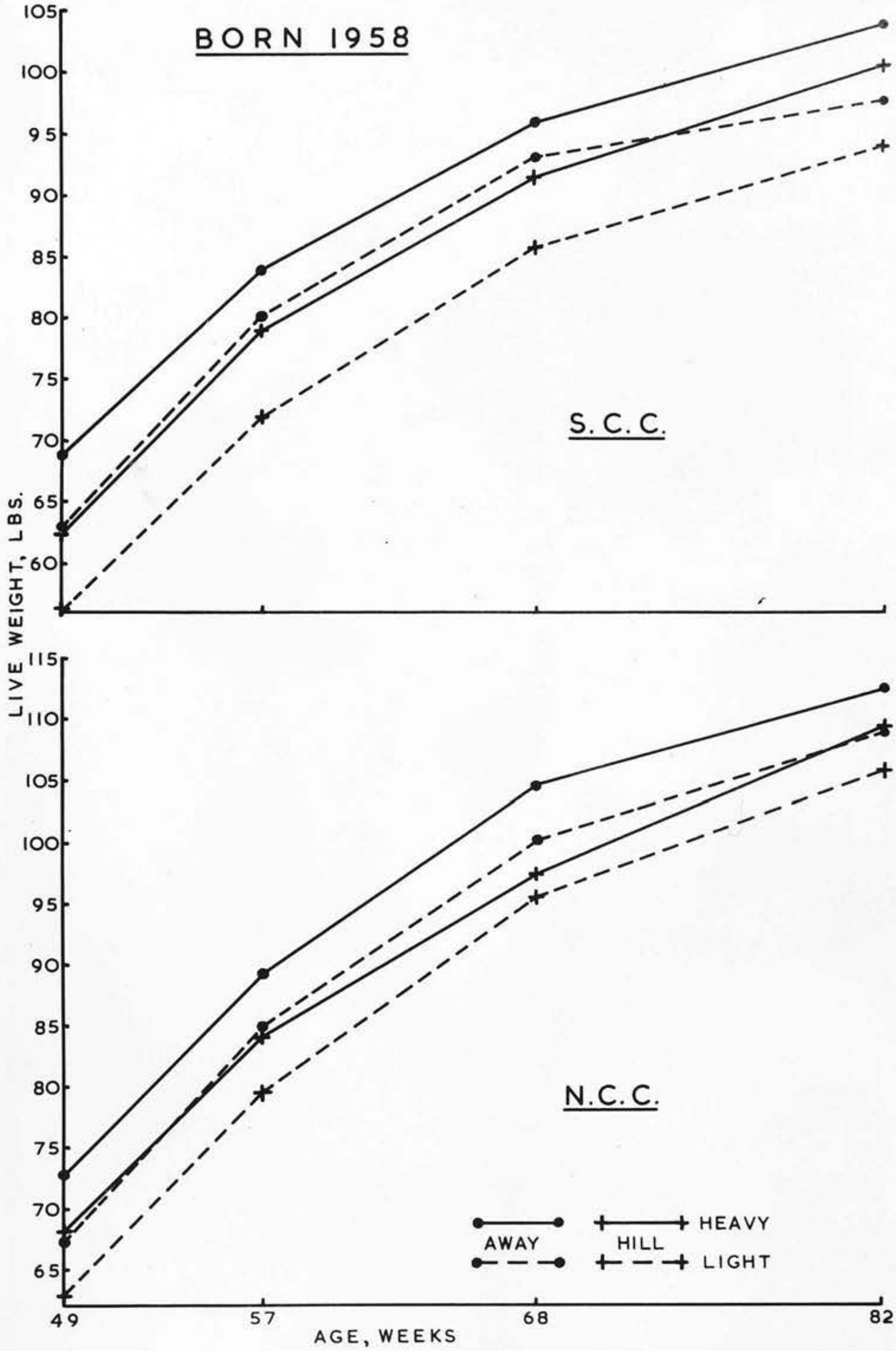

Fig. IVb. Live weight changes over the summer after treatment of heavy and light hoggs prior to treatment.

Born 1956. Having, by means of the different treatments over the winter, completely altered in both breeds the pattern of heavy and light weight classes, with the end of treatment weights ranging from the heaviest sub-group, H.P. heavy, through H.P. light, M.P. heavy, M.P. light and L.P. heavy to the lightest sub-group, L.P. light, interest now lies in the response in terms of live weight of these various sub-groups to an identical summer environment. There are also two different aspects to be considered, the relative response of the heavy and light animals between the different treatment groups and that of the heavy and light animals within each group. Taking the former first, in the S.C.C. heavy weight class the considerable live weight differences between the treatments at 49 weeks were reduced though still present at 80 weeks. In particular the L.P. sub-group showed the most rapid rate of gain while that of the M.P. was very little more than that of the H.P. In the S.C.C. light weight class the H.P. sub-group, which was very much heavier at 49 weeks than the other two sub-groups, maintained its advantage to 80 weeks though to a lesser degree. The other two sub-groups, which differed very little at 49 weeks, lost what difference there was from the L.P. sub-group's more rapid rate of increase.

The S.C.C. light weight picture was repeated by the N.C.C. heavy weight class but with the latter's M.P. and L.P. sub-groups gaining relatively more on the H.P., particularly towards the end of the summer, largely due to the latter's slower rate of gain at this time. In the N.C.C. light weight class the L.P. sub-group remained very much lighter throughout the summer while the difference between the other two sub-groups gradually disappeared, mainly on account of the higher rate of gain by the M.P. sub-group.

Taking the second aspect, that of the response of the two weight classes within each treatment group, shows the S.C.C. H.P. advantage in Fig. III as being due to both weight classes, Fig. IV. The relatively poor increase in the S.C.C. M.P. group appears to be due largely to the light animals, while in the S.C.C. L.P. group, the sub-group live weights differed very little at 49 weeks and remained that way throughout the summer. In the N.C.C. breed, the slower relative growth of the H.P. group appears to be due largely to the light animals, whose rate of increase was slower than that of the heavy. The M.P. sub-groups differed very little at 49 weeks and this difference virtually disappeared over the summer, though it reappeared to a slight extent at 80 weeks. The L.P. sub-groups showed a very similar picture to that of the H.P. with the light animals gaining at a slower rate than the heavy.

By covariance analysis it has been shown at 49 weeks that all the heavy sub-groups differed significantly in the S.C.C. breed and all the light sub-groups differed significantly in the N.C.C. breed. In the S.C.C. light and N.C.C. heavy weight classes, only the H.P. animals were significantly heavier than those of the other two treatments, which were themselves not significantly different. At 57 weeks this was still the case in both breeds with the S.C.C. M.P. and L.P. animals being significantly different in the heavy weight class although these total treatment groups did not differ significantly, see Table 9. By 67 weeks this significance had disappeared and in both S.C.C. weight classes only the H.P. sub-groups differed significantly from the other two. In the N.C.C. breed at this time although all three total treatment groups differed significantly, in the heavy weight class only the H.P. sub-group was significantly heavier than the other two and in the light weight class only the L.P. sub-group was significantly lighter. At 80 weeks no significant difference existed between any of the treatments in the heavy weight class in either breed. In the light weight class, the S.C.C. H.P. sub-group was still significantly heavier than the other two and the N.C.C. L.P. sub-group was still significantly lighter.

Born 1957. In the S.C.C. heavy weight class, the considerable differences between the treatments at 49 weeks had completely disappeared at 79 weeks between the H.P. and M.P. sub-groups and were greatly reduced between these and the Hill sub-group. Most of this reduction took place during the first eight

Table 11

Heavy and light hoggs prior to treatment. Adjusted mean live weights and significance of differences between them over summer after treatment, 12 - 18 months.

		Born 1956											
		S.C.C.						N.C.C.					
		Heavy			Light			Heavy			Light		
Mean age in weeks		H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.
49	(H.P.	83.6(7)+			76.2(6)			94.2(5)			85.3(8)		
	(M.P.	***	70.7(6)		***	60.3(7)		***	75.6(5)		***	73.8(8)	
	(L.P.	***	**	60.7(8)	***	NS	58.6(6)	***	NS	72.4(5)	***	***	62.9(7)
57	(H.P.	92.5(5)			86.2(5)			105.2			96.4(7)		
	(M.P.	**	81.3(4)		**	71.0		**	88.9		*	90.0(7)	
	(L.P.	***	*	73.1	**	NS	70.4(4)	**	NS	90.9	***	***	75.4(6)
67	(H.P.	98.6			93.0			113.2			100.9		
	(M.P.	**	88.8		*	81.1		*	101.7		NS	99.4	
	(L.P.	***	NS	83.7	*	NS	81.7	*	NS	102.5	***	***	84.9
80	(H.P.	104.8			100.7			118.0			105.4		
	(M.P.	NS	96.5		*	88.5		NS	111.4		NS	108.7	
	(L.P.	NS	NS	94.1	*	NS	89.9	NS	NS	110.2	**	***	91.5

+ Number of animals in brackets.
*** = Significant at the 0.1% level of probability.
** = " " " 1% " "
* = " " " 5% " "
NS = Non-significant.

Table 11a

Heavy and light hoggs prior to treatment. Adjusted mean live weights and significance of differences between them over summer after treatment, 12 - 18 months.

Born 1957

Mean age in weeks		S.C.C. Heavy H.P.	M.P.	Hill	S.C.C. Light H.P.	M.P.	Hill	N.C.C. Heavy H.P.	M.P.	Hill	N.C.C. Light H.P.	M.P.	Hill
49	(H.P.	84.8(8)+			81.3(5)			93.7(6)			90.9(8)		
	(M.P.	***	70.8(5)		***	59.7(7)	–	***	75.6(8)		***	71.7(6)	
	(Hill	***	**	59.4(7)	***	NS	52.6(4)	***	***	58.9(6)	***	**	59.0(8)
57	(H.P.	86.4(7)			79.9			94.1			91.4(7)		
	(M.P.	*	79.1(4)		*	70.9(5)		NS	84.9		*	79.9(5)	
	(Hill	**	NS	75.0(6)	***	*	62.3	***	**	72.0	**	NS	73.1(7)
68	(H.P.	93.8			89.4			102.3			96.4		
	(M.P.	NS	89.8		NS	81.2		**	94.1		NS	92.1	
	(Hill	NS	NS	84.8	**	NS	73.5	***	**	83.4	**	*	82.7
79	(H.P.	104.4			97.0(4)			113.8			104.8		
	(M.P.	NS	100.5		NS	92.8		NS	104.4		NS	105.0	
	(Hill	NS	NS	97.4	**	*	79.5	**	*	93.0	NS	NS	93.4

+ Number of animals in brackets.
*** = Significant at the 0.1% level of probability.
** = " " " 1% " "
* = " " " 5% " "

Table 11b

Heavy and light hoggs prior to treatment. Adjusted mean live weights and significance of differences between them over summer after treatment, 12 - 18 months.

Born 1958

Mean age in weeks		S.C.C. Heavy Away	S.C.C. Heavy Hill	S.C.C. Light Away	S.C.C. Light Hill	N.C.C. Heavy Away(9)	N.C.C. Heavy Hill(6)	N.C.C. Light Away(6)	N.C.C. Light Hill(9)
49	(Away	68.9(9)+		62.9(5)		73.4		68.5	
	(Hill	**	62.3(7)	**	56.4(6)	*	67.0	**	61.9
57	(Away	83.9		79.9		89.6		86.4	
	(Hill	NS	79.0	NS	72.3	NS	83.4	*	78.4
68	(Away	95.9(8)		93.0		104.9		101.7	
	(Hill	NS	91.7	NS	86.0	NS	96.8	*	94.3
82	(Away	103.9		97.6		112.8		110.1	
	(Hill	NS	100.8	NS	94.4	NS	108.7	NS	105.0

\+ Number of animals in brackets.
** = Significant at the 1% level of probability.
* = " " " 5% " " "
NS = Non-significant.

weeks after the end of the treatment period with the H.P. animals showing the slowest rate of increase and the Hill the fastest. After 57 weeks the rate of gain of the Hill animals dropped to virtually the same as that of the H.P., while the M.P. animals continued to increase at a faster rate. In the S.C.C. light weight class the pattern of live weight increase was similar to that of the heavy animals without the difference between the H.P. and M.P. sub-groups completely disappearing and with the Hill sub-group showing the slowest rate of gain towards the end of the summer period.

In the N.C.C. heavy weight class the very considerable differences between the treatments at 49 weeks were reduced by 57 weeks; that between the H.P. and M.P. sub-groups being halved but that between the M.P. and Hill sub-groups being only slightly reduced. From 57 - 79 weeks there was little difference between treatments in rate of gain, resulting in still substantial mean differences at 18 months.

In the N.C.C. light weight class the pattern of gain between 49 and 57 weeks was very similar to that of the heavy animals. From 57 weeks onwards the rate of gain of the H.P. sub-group was less than that of either of the other two treatments and the rate of gain of the Hill sub-group was slightly less than that of the M.P. At 79 weeks the H.P. and M.P. sub-groups were almost the same and were still substantially heavier than the Hill.

Considering the response of the two weight classes within each treatment group shows in the S.C.C. H.P. group very similar increases in both weight classes with perhaps a slight tendency for the heavy animals to have a faster rate of gain. This was also the case in the other two S.C.C. treatment groups, particularly in the Hill group, where the heavy animals exhibited a much more rapid rate of gain than the light and were almost as heavy at 79 weeks as the H.P. light animals.

In the N.C.C. breed, the light animals were responsible for the relatively poorer increase in the H.P. group (Fig. IIIa), showing a slower rate of gain than the heavy animals throughout the summer. In the N.C.C. M.P. group, the 5 lb. difference between the weight classes at 49 weeks gradually disappeared over the summer and in the N.C.C. Hill group there was no difference at any time between the weight classes.

By covariance analysis it has been shown at 49 weeks that all the sub-groups in the S.C.C. heavy weight class and in both N.C.C. weight classes differed significantly, while in the S.C.C. light weight class only between the M.P. and Hill sub-groups was the difference not significant. At 57 weeks the picture had changed slightly. In the S.C.C. heavy weight class the difference between the M.P. and Hill sub-groups was no longer significant while in the S.C.C. light weight class the difference between the same two sub-groups had become significant. In the N.C.C. breed, however, the difference between the H.P. and M.P. heavy animals, although substantial, was not significant and the same applied to the difference between the M.P. and Hill light animals.

At 68 weeks, none of the S.C.C. heavy sub-groups differed significantly and only the difference between the S.C.C. H.P. and Hill light animals was still significant. In the N.C.C. heavy weight class at this time, all three treatment differences were once again significant, while in the N.C.C. light weight class, only the Hill sub-group was significantly lighter than the other two. By 79 weeks, the S.C.C. heavy sub-groups were still non-significantly different and the S.C.C. Hill light animals had become significantly lighter than those of the other two treatments, whose difference remained non-significant. In the N.C.C. breed at this time, none of the treatment differences were significant in the light weight class and in the heavy weight class only the Hill animals were significantly lighter than those of the other two treatments.

Born 1958. In both breeds this year the rates of gain in live weight over the summer after treatment were very similar for both treatments in both weight classes, with a slight convergence towards the end leaving reduced and small differences between treatments at 82 weeks. As in the previous years there was a tendency for the heavy animals in both treatments to increase in live weight more rapidly than the light animals over the last 2 - 3 months of the summer period.

By covariance analysis it has been shown at 49 weeks that treatment differences in both weight classes in both breeds were significant. At 57 weeks significance was no longer present in either S.C.C. weight class and this was the case in this breed right through to 18 months. In the N.C.C. breed at 57 weeks and still at 68 weeks, only in the light weight class was the difference between the treatments significant. By 82 weeks this significance had disappeared.

3. From 18 months onwards

(a) Total groups. In Table 12 are shown the actual mean live weights recorded in each experimental age group from 18 months of age to March 1960, giving up to 47 months for the 1956 born animals, up to 35 months for the 1957 born and up to 23 months for the 1958 born. Adjusted means from covariance analysis and the significance of differences between them are shown in Table 13 for the 1956 and 1957 born animals from 18 - 23 months, just prior to first lambing. Statistical analysis has not been carried out on the total groups beyond this age on account of the tremendous variation in mean live weight introduced by differential productivity and a considerable and uneven reduction in total numbers. Covariance analysis has, however, been carried out on the live weights up to $2\frac{1}{2}$ years of age of those animals which produced and then reared a lamb during the gimmer year. Adjusted means and the significance of differences between them are shown for these animals in Table 14.

Born 1956. Over the second winter of life, from 18 - 23 months, both H.P. groups lost approximately 15 lb. while both L.P. groups lost 10 - 11 lb., further reducing the difference between these treatment groups. Both M.P.

Table 12

Mean live weights from 18 months onwards (lb.)

Age in months	S.C.C.			N.C.C.		
Born 1956	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.
18	102.8	91.5	92.6	110.8	110.0	99.7
20	99.4	87.8	91.6	105.2	106.7	97.7
23	87.4	75.5	81.3	96.1	95.5	89.8
25	88.9	80.9	86.0	96.5	100.0	94.1
27	96.4	93.1	93.9	103.8	107.6	101.0
30	111.5	107.4	109.6	119.7	121.8	115.9
32	103.8	100.7	102.0	115.8	120.9	110.4
35	102.6	99.3	102.8	118.3	123.6	113.8
37	107.9	100.9	101.9	115.2	124.2	114.9
39	115.8	104.0	107.8	123.7	130.1	122.9
42	120.0	106.7	110.5	129.8	135.6	131.3
44	117.5	105.2	108.7	119.0	125.8	118.6
47	101.9	90.2	94.9	110.8	118.6	113.5
Born 1957	H.P.	M.P.	Hill	H.P.	M.P.	Hill
18	101.3	97.8	89.2	109.3	104.0	93.2
20	95.3	91.3	85.8	104.3	102.3	93.0
23	94.2	90.9	85.1	104.3	104.4	94.6
25	99.2	95.8	92.6	106.9	106.5	100.8
27	104.0	100.1	97.1	112.5	113.3	107.2
30	109.9	104.6	103.2	121.3	121.8	114.9
32	106.6	102.4	101.3	110.1	112.4	105.4
35	95.3	91.6	88.1	99.1	104.3	96.2
Born 1958	Away	Hill		Away	Hill	
18	101.6	97.7		111.0	107.1	
20	95.8	93.4		102.5	99.3	
23	81.6	79.8		91.7	88.3	

groups lost 15 - 16 lb., similar to the H.P. groups, during this time, and while that in the N.C.C. breed was merely duplicating the H.P. picture, having been similar at 18 months, that in the S.C.C. was unexpected, this group being the lightest at 18 months.

After 23 months, the live weight means were made up of non-producing animals, animals that produced but did not rear and animals that produced and reared. Under these circumstances, live weight comparisons between rearing treatments during the summer are of doubtful value and it is the pre-mating weight in November that probably is of most importance in the sheep year. Even here, though, barren ewes in the preceding season may bias this mean weight through their excessive condition. At 30 months, there was little difference between the S.C.C. treatment groups with the H.P. just the heaviest and the M.P. the lightest. Similarly there were only limited differences between the N.C.C. treatment groups with the M.P. the heaviest and the L.P. the lightest. At 42 months in the S.C.C. breed the actual differences were greater than at 30 months but followed the same pattern. In the N.C.C. breed the differences were still small with the M.P. group still the heaviest but the H.P. group now the lightest.

By covariance analysis it has been shown at 18 months that in the S.C.C. breed only the H.P. group was significantly heavier than the other two while in the N.C.C. breed only the L.P. group was significantly lighter. This was still the case at 20 months but by 23 months the picture had changed. In the S.C.C. breed the H.P. animals were still significantly heavier than those in both the other groups but the M.P. animals had lost so much weight that they had become significantly lighter than those in the L.P. group. In the N.C.C. breed at this time, differences between treatments were no longer significant.

At 25 months, the S.C.C. H.P. animals that had produced a lamb were still significantly heavier than those that had also produced in the other two groups. At 27 and 30 months there was no significant treatment difference between those

Table 13

Adjusted mean live weights and significance of differences between them from 18 months onwards.

Born 1956

Mean age in months		S.C.C. H.P.	S.C.C. M.P.	S.C.C. L.P.	N.C.C. H.P.	N.C.C. M.P.	N.C.C. L.P.
18	(H.P.	102.6(10)+			110.9(12)		
	(M.P.	***	92.1(11)		NS	109.6(12)	
	(L.P.	***	NS	92.3(12)	**	**	100.0(11)
20	(H.P.	98.5(9)			105.1(11)		
	(M.P.	**	88.8(10)		NS	106.6(11)	
	(L.P.	*	NS	91.5(11)	*	*	97.9(10)
23	(H.P.	86.8			96.1		
	(M.P.	***	76.2		NS	95.4	
	(L.P.	*	*	81.1	NS	NS	89.9

Born 1957

Mean age in months		S.C.C. H.P.	S.C.C. M.P.	S.C.C. Hill	N.C.C. H.P.	N.C.C. M.P.	N.C.C. Hill
18	(H.P.	101.9(11)			109.2(13)		
	(M.P.	NS	96.4		NS	104.1(13)	
	(Hill	**	NS	89.8(10)	***	**	93.6(13)
20	(H.P.	95.1(10)			104.3(12)		
	(M.P.	NS	89.9(8)		NS	102.1(12)	
	(Hill	NS	NS	87.2(9)	**	*	93.1(12)
23	(H.P.	94.0			104.3		
	(M.P.	NS	89.6		NS	104.3	
	(Hill	*	NS	86.5	**	**	94.7

+ Number of animals in brackets.
*** = Significant at 0.1% level of probability.
** = " " 1% " " "
* = " " 5% " " "
NS = Non-significant.

Table 14

Adjusted mean live weights and significance of differences between them of gimmers that produced and then nursed a lamb.

Born 1956

Mean age in months		S.C.C. H.P.	S.C.C. M.P.	S.C.C. L.P.	N.C.C. H.P.	N.C.C. M.P.	N.C.C. L.P.
25	(H.P.	88.7(5)+			96.3(9)		
	(M.P.	*	78.3(6)		NS	99.1(8)	
	(L.P.	*	NS	81.2(7)	NS	NS	91.0(7)
27	(H.P.	87.5(3)			95.9(4)		
	(M.P.	NS	82.5(1)		NS	104.1(6)	
	(L.P.	NS	NS	84.3(3)	NS	*	91.9(4)
30	(H.P.	100.5			113.1		
	(M.P.	NS	97.5		NS	119.7	
	(L.P.	NS	NS	96.6	NS	NS	107.8

Born 1957

Mean age in months		S.C.C. H.P.	S.C.C. M.P.	S.C.C. Hill	N.C.C. H.P.	N.C.C. M.P.	N.C.C. Hill
25	(H.P.	93.0(7)			103.5(10)		
	(M.P.	NS	87.7(5)		NS	105.0(10)	
	(Hill	NS	NS	87.4(6)	NS	NS	97.5(9)
27	(H.P.	94.9			106.5		
	(M.P.	NS	90.9		NS	110.5	
	(Hill	NS	NS	87.3	NS	NS	101.7
30	(H.P.	100.6			115.6		
	(M.P.	NS	95.3		NS	120.2	
	(Hill	NS	NS	94.9	NS	*	110.5

+ Number of animals in brackets.
* Significant at 5% level of probability.
NS = Non-significant.

gimmers that had nursed a lamb. At 25 months in the N.C.C. breed there was no significant treatment difference between the gimmers that had produced a lamb but at 27 months the M.P. nursing gimmers were significantly heavier than those nursing in the L.P. group. This significance had disappeared by 30 months although the mean difference was still considerable.

Born 1957. Over the second winter of life, from 18 - 23 months, live weight losses were much less severe in this year, the S.C.C. H.P. and M.P. groups both losing 7 lb. and the S.C.C. Hill group only 4 lb., again reducing the effects of treatment. Only the N.C.C. H.P. group lost weight, 5 lb., while the N.C.C. M.P. and Hill groups virtually maintained their weight at the 18 month level.

At 30 months in the S.C.C. breed, the H.P. animals were still slightly heavier than those in the other two groups while in the N.C.C. breed the H.P. and M.P. animals were a similar weight and also heavier than those in the Hill group.

By covariance analysis it has been shown at 18 months that in the S.C.C. breed only the H.P. group was significantly heavier than the Hill group, no other difference in this breed being significant, while in the N.C.C. breed only the Hill group was significantly lighter than the other two. This remained the situation in the N.C.C. breed at 20 and 23 months of age but in the S.C.C. breed at 20 months the significance had disappeared although it reappeared between the H.P. and Hill groups at 23 months.

There was no significant treatment difference at 25 months between the gimmers that had produced a lamb in either breed. Neither was there any significant treatment difference at 27 or 30 months between the S.C.C. gimmers that had nursed a lamb. In the N.C.C. breed, however, although there was no significant treatment difference between those gimmers nursing at 27 months, by 30 months those that had nursed in the M.P. group were significantly heavier than those that had nursed in the Hill group.

<u>Born 1958</u>. Over the second winter of life, from 18 - 23 months, losses in weight were very heavy this year, both Away groups losing 19 - 20 lb. and both Hill groups losing 18 - 19 lb. As no significant difference was present at 18 months between the treatments in either breed and the actual differences were very small, no further analysis was carried out on this year's live weights.

(b) <u>Heavy and light hoggs prior to treatment</u>. In Tables 15, 15a and 15b are shown the actual mean live weights recorded in each experimental age group from 18 months of age to March 1960 of the heavy and light hoggs prior to treatment. Adjusted means from covariance analysis and the significance of differences between them are shown in Table 16 for the 1956 and 1957 born animals from 18 - 23 months.

<u>Born 1956</u>. Over the second winter of life, from 18 - 23 months, both weight classes in the S.C.C. H.P. and M.P. groups lost approximately the same amount of weight, from 15 - 16 lb. but the S.C.C. L.P. heavy and light animals only lost 12 and 10 lb. respectively. In the N.C.C. breed, the heaviest loss during this time was 18 lb. by the H.P. heavy animals, with the H.P. light animals only losing 12 lb. The M.P. heavy and light and the L.P. heavy animals all lost approximately the same, from 14 - 15 lb., while the L.P. light only lost 8 lb.

This had the effect of generally reducing the differences caused by treatment with the result that by 30 months there was virtually no difference between the heavy sub-groups in either breed and only in the N.C.C. breed was there still any difference between the light sub-groups, the L.P. animals being considerably lighter than those of the other two treatments. A further effect at this time was an increase in the within group difference between the heavy and light sub-groups with the latter reverting to their initial status of being lighter than any of the former regardless of treatment.

At 42 months in the S.C.C. breed, both weight classes in the H.P. group were heavier than their respective sub-groups in the other two treatments.

Table 15

Heavy and light hoggs prior to treatment.
Mean live weights from 18 months onwards (lb.)

Born 1956

Age in months	S.C.C. H.P. Heavy	S.C.C. H.P. Light	S.C.C. M.P. Heavy	S.C.C. M.P. Light	S.C.C. L.P. Heavy	S.C.C. L.P. Light	N.C.C. H.P. Heavy	N.C.C. H.P. Light	N.C.C. M.P. Heavy	N.C.C. M.P. Light	N.C.C. L.P. Heavy	N.C.C. L.P. Light
18	105.2	100.4	96.5	88.7	93.9	90.0	118.0	105.6	112.2	108.4	109.4	91.7
20	102.8	95.2	95.3	85.5	93.6	88.2	111.8	99.7	108.6	105.2	106.4	89.0
23	90.0	84.3	80.0	73.5	81.9	80.3	99.8	93.0	97.0	94.2	95.6	84.0
25	88.8	89.0	88.0	75.2	88.0	82.5	101.0	92.8	109.0	95.5	102.8	83.3
27	100.2	90.0	98.5	88.8	95.3	91.5	107.5	101.3	113.0	104.8	111.5	92.6
30	114.4	106.7	112.0	103.8	111.3	106.8	126.0	115.5	131.7	116.8	127.2	104.6
32	105.4	101.0	109.3	96.3	103.7	99.0	121.5	112.0	127.0	116.3	121.2	99.6
35	104.0	100.3	108.3	94.8	103.1	102.3	123.8	114.7	127.3	121.7	123.6	104.0
37	111.4	102.0	110.7	96.0	104.7	96.8	123.8	109.5	128.3	122.2	124.6	105.2
39	120.0	108.7	115.3	96.0	111.6	101.3	139.5	113.2	130.7	129.8	134.0	111.8
42	124.6	112.3	119.3	100.3	114.3	103.8	142.0	121.7	138.5	134.7	143.6	119.0
44	121.0	111.7	117.7	100.3	111.9	103.3	130.5	111.3	129.5	124.5	128.0	109.2
47	104.8	97.0	100.7	85.0	97.3	90.8	121.5	103.7	120.0	118.2	124.0	103.0

Table 15a

Heavy and light hoggs prior to treatment.
Mean live weights from 18 months onwards (lb.)

Born 1957

Age in months	S.C.C. H.P. Heavy	S.C.C. H.P. Light	S.C.C. M.P. Heavy	S.C.C. M.P. Light	S.C.C. Hill Heavy	S.C.C. Hill Light	N.C.C. H.P. Heavy	N.C.C. H.P. Light	N.C.C. M.P. Heavy	N.C.C. M.P. Light	N.C.C. Hill Heavy	N.C.C. Hill Light
18	103.9	96.8	103.8	93.0	95.7	79.5	113.8	105.4	104.4	103.4	93.0	94.0
20	97.3	90.7	94.8	87.8	93.4	76.3	112.4	98.6	102.1	102.5	95.4	91.3
23	96.3	89.3	94.5	87.3	88.0	81.5	109.6	100.4	104.9	103.5	96.2	93.4
25	100.6	96.0	102.0	89.5	99.2	84.3	114.0	101.9	108.3	102.8	109.6	94.9
27	105.4	100.7	106.0	94.3	106.8	81.0	119.0	107.2	114.9	110.3	115.4	101.3
30	112.1	104.7	111.5	97.8	112.0	92.3	127.2	116.3	123.3	118.8	122.8	109.2
32	109.1	100.7	108.3	96.5	109.2	91.5	117.6	103.8	114.5	108.3	112.0	100.7
35	97.0	91.3	94.0	89.3	94.4	80.3	98.4	99.7	105.6	101.5	100.8	92.9

Table 15b

Born 1958

Age in months	S.C.C. Away Heavy	S.C.C. Away Light	S.C.C. Hill Heavy	S.C.C. Hill Light	N.C.C. Away Heavy	N.C.C. Away Light	N.C.C. Hill Heavy	N.C.C. Hill Light
18	104.0	97.8	100.7	94.2	112.4	108.8	109.3	105.7
20	97.3	93.6	96.9	89.3	104.2	99.8	100.3	98.6
23	84.1	77.6	82.7	76.3	93.7	88.8	90.8	86.7

Table 16

Heavy and light hoggs prior to treatment. Adjusted mean live weights and significance of differences between them from 18 months onwards.

Born 1956

Mean age in months		S.C.C. Heavy H.P.	S.C.C. Heavy M.P.	S.C.C. Heavy L.P.	S.C.C. Light H.P.	S.C.C. Light M.P.	S.C.C. Light L.P.	N.C.C. Heavy H.P.	N.C.C. Heavy M.P.	N.C.C. Heavy L.P.	N.C.C. Light H.P.	N.C.C. Light M.P.	N.C.C. Light L.P.
18	(H.P.	104.8(5)+			100.7(5)			118.0(5)			105.4(7)		
	(M.P.	NS	96.5(4)		*	88.5(7)		NS	111.4(5)		NS	108.7(7)	
	(L.P.	NS	NS	94.1(8)	*	NS	89.9(4)	NS	NS	110.2(5)	**	***	91.5(6)
20	(H.P.	101.7			95.3(4)			111.8			99.3(6)		
	(M.P.	NS	94.6(3)		NS	84.6		NS	107.7		NS	105.8(6)	
	(L.P.	NS	NS	94.7(7)	NS	NS	88.3	NS	NS	107.3	*	**	88.8(5)
23	(H.P.	89.4			84.4			99.8			92.8		
	(M.P.	NS	79.6		**	73.5		NS	96.2		NS	94.4	
	(L.P.	NS	NS	82.6	NS	*	80.4	NS	NS	96.4	*	*	83.9

Born 1957

Mean age in months		S.C.C. Heavy H.P.	S.C.C. Heavy M.P.	S.C.C. Heavy Hill	S.C.C. Light H.P.	S.C.C. Light M.P.	S.C.C. Light Hill	N.C.C. Heavy H.P.	N.C.C. Heavy M.P.	N.C.C. Heavy Hill	N.C.C. Light H.P.	N.C.C. Light M.P.	N.C.C. Light Hill
18	(H.P.	104.4(7)			97.0(4)			113.8(6)			104.8(7)		
	(M.P.	NS	100.5(4)		NS	92.8(5)		NS	104.4(8)		NS	105.0(5)	
	(Hill	NS	NS	97.4(6)	**	*	79.5(4)	**	*	93.0(6)	NS	NS	93.4(7)
20	(H.P.	97.8			91.9(3)			112.4(5)			98.4(7)		
	(M.P.	NS	91.4		NS	86.6(4)		NS	102.1(8)		NS	103.1(4)	
	(Hill	NS	NS	95.3(5)	*	NS	76.6	*	NS	95.4(5)	NS	NS	91.1(7)
23	(H.P.	96.9			92.7			109.0			100.3		
	(M.P.	NS	90.6		NS	83.9		NS	105.4		NS	103.8	
	(Hill	NS	NS	90.2	NS	NS	82.3	NS	NS	95.9	NS	NS	93.3

+ Number of animals in brackets.
*** = Significant at 0.1% level of probability.
** = " " 1% " " "
* = Significant at 5% level of probability.
NS = Non-significant.

In the N.C.C. breed at this time there was little difference between the heavy animals but the M.P. light animals were considerably heavier than those of the other two treatments.

By covariance analysis it has been shown at 18 months that only in the light weight class in both breeds was there any significant difference between treatments. The S.C.C. H.P. light animals were significantly heavier than those in both the M.P. and L.P. groups and the N.C.C. L.P. light animals were significantly lighter than those in both the H.P. and M.P. groups. In neither heavy weight class were any of the differences between treatments significant at 18, 20 or 23 months. In the S.C.C. light weight class at 20 months the significance had disappeared but by 23 months the M.P. light animals had lost so much weight that they had become significantly lighter than both the H.P. and L.P. light animals which did not differ significantly. In the N.C.C. light weight class the situation at 18 months was maintained to 20 and 23 months.

Born 1957. Over the second winter of life, from 18 - 23 months, the three S.C.C. heavy weight sub-groups lost similar amounts ranging from 7 - 9 lb. The S.C.C. H.P. light animals lost 8 lb., the M.P. light lost 6 lb., while the Hill light gained 2 lb. In the N.C.C. breed both H.P. sub-groups lost 4 - 5 lb. while both M.P. sub-groups and the Hill light maintained their weights at the 18 month level. The N.C.C. Hill heavy animals, which were relatively light at 18 months, gained 3 lb. over the period.

This had the effect of reducing the differences created by treatment with the result that by 30 months there was little difference between the heavy sub-groups in either breed with only the N.C.C. H.P. animals having a very slight advantage. In the light weight class, however, both Hill sub-groups were still lighter than their respective H.P. and M.P. sub-groups at this time. As with the 1956 born animals there was an increase at 30 months in the within group differences between the weight classes with all the light sub-groups being lighter than all the heavy sub-groups regardless of treatment.

By covariance analysis it has been shown at 18 months that none of the differences between treatment means in the S.C.C. heavy and N.C.C. light weight classes were significant. This situation remained the same at 20 and 23 months. In the S.C.C. light and N.C.C. heavy weight classes, however, the Hill sub-groups at 18 months were significantly lighter than their respective H.P. and M.P. sub-groups which were not significantly different in either weight class. At 20 months only the difference between the H.P. and Hill sub-groups was still significant and at 23 months this significance had also disappeared although the mean weights still differed considerably.

Born 1958. Over the second winter of life, from 18 - 23 months, both weight classes in the two Away groups lost 19 - 20 lb., while both weight classes in the two Hill groups lost 18 - 19 lb., reducing slightly the already small differences resulting from treatment.

4. Live weight discussion

(a) Treatment period, 6 - 12 months. In the design of this study live weight changes over the treatment period were the planned criteria for differentiating between treatments, the rations fed to the indoor groups being varied in order to achieve the required changes. With the 1956 born age group, some difficulty was met in lowering the L.P. live weights when on an artificial diet, but was ultimately achieved. With the 1957 born age group, it was fortunate that the winter was of average severity and created an average live weight decrease in the Hill groups, unlike the 1958 born age group where a mild winter altered the Hill treatment virtually into a M.P. This uncontrollable variation due to season is one of the problems always present in the design of an experiment of this nature. Another complication which arose in the first two years was a drop in live weight, or at least a check in live weight increase, which occurred when an artificial diet was fed indoors. The changes in diet and also habitat were most likely the cause of this and it is

Table 17

Live weights of H.P. and M.P. groups expressed as a percentage of L.P. over treatment period.

Born 1956

Mean age in weeks	S.C.C. H.P.	S.C.C. M.P.	N.C.C. H.P.	N.C.C. M.P.
27	102	101	100	100
29	100	98	97	99
32	103	97	96	99
35	106	102	101	101
38	113	101	110	105
41	117	104	114	112
44	123	107	116	107
47	135	109	131	115
49	135	111	134	113

Live weights of H.P. and M.P. groups expressed as a percentage of Hill wintered over treatment period.

Born 1957

Mean age in weeks	S.C.C. H.P.	S.C.C. M.P.	N.C.C. H.P.	N.C.C. M.P.
22	101	103	101	100
28	96	95	98	96
35	99	97	107	101
41	116	108	121	111
49	147	118	157	124

Live weights of Away wintered groups expressed as a percentage of Hill wintered over treatment period.

Born 1958

Mean age in weeks	S.C.C. Away	N.C.C. Away
25	101	100
30	102	101
49	112	109

undoubtedly a problem particularly where steady growth on a H.P. diet is desired.

In general it can be said that the treatments had very little effect on live weight until the end of the year and most of the differences between treatment groups were created after this time. This is probably due to some extent to the check in live weight increase discussed above. As most of the Hill group live weight losses also occurred after the turn of the year, with only a gradual levelling off before that, it is this period from January to April that is of most importance. The feeding of a H.P. diet prior to this seems to be of only limited advantage in terms of live weight increase. This is demonstrated in Table 17 where the live weights of H.P., M.P. and Away groups are shown relative to their respective L.P. or Hill group, at 35 weeks there being little difference in any year with either breed, compared to the differences existing by 49 weeks.

In theory it should be possible to assume that all animals have an ultimate size and weight given ideal conditions of feeding and management. As a result, again in theory, it should be possible to assume that animals selected as being either heavy or light at an early stage of their growth, are so on account of some earlier privation and given the opportunity will eventually eliminate the difference between them. It was with this in mind that the present study was planned to examine the effects of different treatments on the relative responses of the two weight classes. However, in practice it is not quite so simple as that, as no matter what conditions are offered, there are certain animals which are genetically incapable of achieving the weight and size of the flock mean and conversely there are others which are capable, given the opportunity, of greatly surpassing the flock mean. As a result, it is possible at six months of age to select animals as being light which are so either genetically and are therefore incapable of improvement or are so on account of earlier privation. It is also possible to select animals as being heavy which are either genetically light and having been well reared will respond very little more or are genetically heavy and have been partially retarded by privation. There being no way of recognising these different types at an early age, when selecting treatment groups according to live weight, may introduce a variability in results from the heavy and light sub-groups at a later date which makes them difficult to interpret. In spite of this inherent weakness, however, the live weight changes which occurred in the different treatment sub-groups did more or less follow, with certain exceptions, a predictable pattern.

In general, in terms of live weight increase, light animals responded more on a H.P. diet and suffered less on a L.P. or Hill diet than heavy animals (Table 6). The light animals have a greater potential for live weight increase in terms of both body tissue and gut-fill which is realised on a H.P. diet. Also, being smaller, their maintenance requirements are less and on a L.P. or Hill diet they therefore lost less weight than the larger heavy animals.

In all three years, the above pattern was followed in both breeds in the H.P. and Away groups, with the 1957 born sub-groups exhibiting much greater gains than was the case with the 1956 and 1958 born. In the L.P. and Hill groups the pattern was not so obvious. In the 1958 born age group, it was shown in both breeds by a smaller increase in the heavy animals in place of a greater loss as shown by this weight class in the 1956 born S.C.C. L.P. and the 1957 born S.C.C. and N.C.C. Hill groups. In the 1956 born N.C.C. L.P., both weight classes lost relatively the same amount, a result which compares unfavourably with the 1957 born N.C.C. Hill group, which was, however, rather extreme in that the difference between the weight classes completely disappeared (Table 5a and Fig. IIa). It would therefore seem that the heavy animals in these groups have responded to their L.P. and Hill diets in entirely different ways, possibly due to the errors in selection technique discussed earlier complicated in the first year by group feeding in a pen and its resultant competition for the available food supply.

A M.P. or maintenance diet has produced some variable results in the

Table 18

Heavy and light hoggs prior to treatment.

Live weights of H.P. and M.P. sub-groups expressed as a percentage of corresponding L.P. sub-groups over treatment period.

Born 1956

Mean age in weeks		S.C.C. H.P.	S.C.C. M.P.	N.C.C. H.P.	N.C.C. M.P.
27	Heavy	104	102	102	104
	Light	99	104	99	98
49	Heavy	140	118	133	109
	Light	130	105	135	117

Live weights of H.P. and M.P. sub-groups expressed as a percentage of corresponding Hill wintered sub-groups over treatment period.

Born 1957

Mean age in weeks		S.C.C. H.P.	S.C.C. M.P.	N.C.C. H.P.	N.C.C. M.P.
22	Heavy	101	105	101	99
	Light	98	109	100	97
49	Heavy	145	126	160	127
	Light	151	117	154	119

Live weights of Away wintered sub-groups expressed as a percentage of corresponding Hill wintered sub-groups over treatment period.

Born 1958

Mean age in weeks		S.C.C. Away	N.C.C. Away
25	Heavy	99	97
	Light	101	96
49	Heavy	110	107
	Light	112	107

relative responses of the two weight classes in both years. With the exception of the 1957 born S.C.C. M.P. group, in general the light animals have either gained more or lost less than the heavy animals, this has ranged from the 1957 born N.C.C. M.P. group where both weight classes gained, through the 1956 born N.C.C. M.P. group where the heavy animals lost and the light gained, to the 1956 born S.C.C. M.P. group where both weight classes lost. The 1957 born S.C.C. M.P. group situation, where the heavy animals gained more than the light, was largely due to the latter being very much heavier initially relative to the other light sub-groups, in fact significantly so (see Table 5a), and therefore not responding to the treatment relatively as much as the heavy animals. Errors in selection and group feeding competition also probably play a part in the variable results obtained in the two weight classes on a M.P. diet. It seems probable that with group feeding in a pen, only when a H.P. or ad lib. diet is being fed will it be possible to ignore the competitive factor as one affecting relative responses of sub-groups within any one group. When less than an ad lib. diet for all is being fed, certain animals will be unable to claim their fair share of the available nutrients due to psychological inferiority.

In Table 18 are shown the live weights of each weight class in the H.P., M.P. and Away groups relative to that of the respective weight class in the L.P. and Hill groups. Only the pre-treatment and post-treatment values are shown and while the variability in the L.P. and Hill responses discussed above results in slight variations in the relative responses of the other treatment groups, this table nevertheless demonstrates the effects of treatment on the heavy and light hoggs within the flock from 6 - 12 months of age.

The significance of differences due to treatment in the whole flock and in the heavy and light hoggs within the flock can be compared by examination of Tables 3, 7, 7a and 7b.

In all three years, the treatments created significant differences in live weight in the total flock by 49 weeks. With two exceptions, significant differences existed in both weight classes. The main exception was in the S.C.C. breed, where in both the 1956 and 1957 born age groups the difference between the M.P. and L.P. or Hill animals was significant only in the heavy weight class. The light animals in these treatment groups did not differ significantly at 49 weeks of age after 22 and 27 weeks treatment in 1956 and 1957 respectively. The other exception was in the N.C.C. 1956 born age group where at 49 weeks of age after 22 weeks treatment, the difference between the M.P. and L.P. animals was significant only in the light weight class, with the heavy animals not differing significantly after these treatments.

The S.C.C. situation was almost certainly due to the very little effect that a L.P. or Hill diet had on the light animals in these treatment groups. This was not repeated in the N.C.C. breed, possibly on account of their greater initial weight but more probably on account of the greater gain in weight on the part of the M.P. light animals relative to those of the S.C.C. breed. The N.C.C. heavy situation is more difficult to explain but it appears mainly due to the failure of the heavy animals to lose as much weight on an artificial L.P. diet as they would under a natural Hill wintered environment.

(b) Summer after treatment, 12 - 18 months. It is obvious that season plays a large part in the response of the different treatment groups in terms of live weight increase over the summer after treatment. There is probably a close relationship between live weight at 12 months of age and the rate of gain during the summer which may be strongly affected by the summer environment. This is demonstrated in Figs. III, IIIa and IIIb, where different seasons have resulted in different live weight curves over the summer, particularly in the H.P. and Away treatment groups. However, the nett result of these variations was to produce H.P. and Away reared animals of identical weight at 18 months within both breeds over the three years.

The response of the L.P. and Hill wintered groups over the summer, while also affected by the season, seems to be more closely related to the 12 month weight than was the case with the H.P. and Away groups, there being considerably more variation at 18 months in the former, although there was very similar variation at 12 months between the three years' weights of both these extreme treatments. The M.P. groups tended to follow a similar pattern though with some breed difference in 1956.

In general, the more retarded a group was over the winter, the faster its live weight increased over the summer, particularly during the first two months. Basically this agrees with the findings of most other workers as discussed in the Review of Literature. However, it requires further consideration in view of the much reduced differences in live weight increase between treatments from 57 weeks onwards. Live weight is a complex of basic body tissues, excess fat and gut-fill. With the H.P. groups born 1956 and 1957 and to a lesser extent the Away groups born 1958, live weight increased considerably over the winter and was probably due to all the components mentioned above. In the 1956 born H.P. groups, their potential for live weight increase was not exceeded during the winter and they continued to increase at an even rate in the spring, no doubt assisted by a fairly good season. In the 1957 born H.P. groups, their potential for live weight increase was probably achieved over the winter and a considerable amount of fat laid down with certainly plenty of gut-fill. In the below average season of 1958 they received a check in live weight increase due to a probable reduction in these two components but then having developed the basic body tissues they were able to recover and continue their live weight increase. In the 1958 born Away groups, live weight increase over the winter was very limited and in the spring their potential for live weight increase in all its components was still considerable and as a result they increased in weight very rapidly, assisted by a good season.

In the L.P. and Hill groups and to a lesser extent in the M.P. groups, live weights decreased or were increased to a limited degree over the winter.

Those body tissues whose potential for growth was at a maximum at that time no doubt continued to grow at the expense of others, although possibly only slowly, while fat deposition and also gut-fill were greatly reduced. In the spring, their potential for live weight increase in all its components was considerable and the first effect of an improved diet was greatly increased gut-fill with some fat deposition. This probably accounts for the immediate upsurge in weight between 49 and 57 weeks and the weight differences between treatments at 57 weeks may therefore be much more accurate indices of the differences caused by treatment in the basic body tissues of bone and muscle.

In the first two experimental age groups, the 1956 and 1957 born, the difference in weight between the two extreme treatment groups at 12 months in both breeds was approximately halved by 18 months. In the 1958 born age group there was a similar trend although the actual differences involved were very small. With the exception of the 1956 born S.C.C. M.P., the M.P. groups in general tended to maintain their advantage over the respective L.P. or Hill groups and as a result their live weights at 18 months were very little less than those of the H.P. groups.

In the heavy and light weight classes there was a tendency, particularly in the N.C.C. breed, for the two extreme sub-groups, H.P. or Away heavy and L.P. or Hill light, to maintain to a large extent their relative differences while the other sub-groups failed to do so and at 18 months were at approximately the same live weight, intermediate between the two extremes. The light weight sub-groups, regardless of treatment, appeared to have less potential for live weight increase over the summer than the heavy weight sub-groups, their rate of increase slowing up relative to the latter. This suggests that the treatments, although altering light animals into heavy at 12 months, failed to create any permanent changes and that those animals which were light at 6 months were probably genetically so, or having been retarded in very early life, they were, by 6 months, beyond the stage of growth and development where treatment could have any lasting effect.

In spite of the considerable reduction in live weight differences between the treatments over the summer, at 18 months the H.P. groups in both breeds were still significantly heavier than their respective L.P. and Hill groups in the 1956 and 1957 born age groups. In the 1958 born age group the treatment differences, being small initially, were no longer significant at 18 months. Both N.C.C. M.P. groups, having rapidly gained on the H.P. groups over the summer, were also still significantly heavier than their respective L.P. and Hill groups though the differences between the M.P. and H.P. groups were no longer significant. The performance of the S.C.C. M.P. groups was more varied, the 1956 born group being the same weight as the L.P. group and also being significantly lighter than the H.P. group, while the 1957 born group took an intermediate position being non-significantly different from both the H.P. and Hill groups.

When the different weight classes are considered, it becomes apparent that in the S.C.C. breed where there were no significant differences between the heavy sub-groups at 18 months in any year, it was the significantly different light sub-groups in the 1956 and 1957 born age groups that were causing the total treatment groups to differ significantly. This was largely due to the retarded live weight increase of the light animals in the poorer wintered groups, particularly the 1957 born Hill light animals. This situation was repeated in the N.C.C. 1956 born age group but in the N.C.C. 1957 born age group it was not apparent, probably due to the relatively light Hill heavy animals and the relatively heavy Hill light animals which were of similar weight after the treatment period and were still so at 18 months.

That the effects of treatment seem to persist more in the light animals than the heavy is further demonstrated in the 1958 born age group, where the N.C.C. light animals were the only ones to show a significant treatment difference after 12 months of age.

(c) From 18 months onwards. While the extent of loss in weight over the winter from 18 - 23 months of age is largely dependent on the severity of the winter, the condition of the animals at 18 months also plays a part. In the three experimental age groups, the degree of loss varied considerably between years but within any one year the heaviest animals, namely those in the H.P., M.P. and Away groups, lost much more weight relative to those in the L.P. and Hill groups. This can be attributed both to having a greater degree of condition and also to being larger with its resultant greater maintenance requirements. In general this had the effect of further reducing the differences between the groups created by treatment.

The very heavy loss experienced by the 1958 born age group between 18 and 23 months while to a certain extent due to the winter environment nevertheless suggests an excessive degree of condition resulting from the good summer of 1959. That this was so seems very likely in view of the very limited treatment effects during the first winter and the rapid and considerable live weight increase during the first half of the summer. This may imply very much reduced development resulting from treatment with resultant smaller size than was the case with the 1956 and 1957 born H.P. animals. The 1958 born animals having put on a lot of condition during the summer probably disguised this fact but the following winter, by taking all the condition off again, has reintroduced the possibility.

As has been mentioned previously, mean live weights after 23 months were subject to considerable variation due to differential productivity and uneven reduction in numbers. However, Table 12 shows the unadjusted live weight changes occurring over several years. The main point of interest in this is the relative position of the M.P. groups in the two breeds. In both years the N.C.C. M.P. groups had become the heaviest while the S.C.C. M.P. groups remained relatively lighter than the H.P. and similar to the L.P. and Hill. With advancing age the N.C.C. L.P. and Hill groups continued to catch up on the

H.P. until there was virtually no difference between them. This was not the case in the S.C.C. breed, the H.P. groups maintaining their advantage to some extent as far as these records go.

In both weight classes in general it can be said that the heavier sub-groups at 18 months lost more weight over the winter than the lighter sub-groups. This further reduced the differences due to treatment. With the seasonal variation that existed, certain sub-groups, those which were unexpectedly light at 18 months, namely the 1957 born S.C.C. Hill light and N.C.C. Hill heavy, actually gained weight over the winter, a fact which helped to eliminate some of the exceptions to the pattern showing at 18 months.

By 30 months there were virtually no differences between treatments in the heavy weight class in either breed in either year. In the light weight class at this time the N.C.C. L.P. and Hill sub-groups were both still lighter than their respective H.P. and M.P. sub-groups suggesting that it is the light animals at 6 months which are relatively most affected by below optimum wintering. This was also the case in the 1957 born S.C.C. Hill group but the artificially wintered 1956 born S.C.C. L.P. group did not show the same picture, the light animals being very little lighter than the heavy at 18 months and relatively heavy for their weight class after such a treatment.

The N.C.C. M.P. light animals by being the heaviest in their weight class in both years at 30 months appear to be responsible for the heavier mean weights of these total groups, while similarly it is apparently the S.C.C. M.P. light animals which were responsible for the lighter mean weights occurring in their total groups. With advancing age this point becomes even more striking, as is shown by the mean weights at 42 months in the 1956 born age group.

Within each treatment group the difference between the weight classes, while reducing during the winter, increased by the following autumn to a greater extent each succeeding year. This indicates the greater potential for live weight increase inherent in the heavier animals at 6 months of age regardless of treatment and provides added proof that light animals at that age are either genetically so or having been retarded in early life are beyond the stage of development where wintering treatment can overcome the deficit. Treatment, however, does have some effect as the differences between the weight classes in the L.P. and Hill groups increased to a greater relative extent than they did in the H.P. groups at each succeeding autumn, particularly in the 1957 born age group where natural hill wintering gave less unpredictable results with the two weight classes than did the artificial L.P. in the 1956 born age group.

In spite of the reduction in treatment differences over the winter from 18 - 23 months the 1956 and 1957 born S.C.C. H.P. groups and the 1957 born N.C.C. H.P. group were still significantly heavier than their respective L.P. or Hill groups at 23 months, just prior to first lambing. The M.P. groups, being very varied in their response, have been discussed in the previous sections. With those gimmers which nursed a lamb, only in the N.C.C. breed was there any persistent trend towards significance between the group means over the summer, namely between the M.P. and L.P. or Hill groups.

When the two weight classes are considered, while there were still significant differences in the 1956 born light weight classes as discussed earlier in the relevant section, the main trend was for the treatment differences to be non-significant at 23 months although some were still sizable. Small numbers and considerable within group variation are undoubtedly the cause of failure to demonstrate significance in these cases.

III <u>Live measurements</u>

The degree of repeatability of each measurement recorded by the author is shown in Table 19. These are intraclass correlations calculated from duplicated readings taken on 78 animals in both breeds and are all highly significant (Snedecor, 1956). In order of accuracy, the two single bone measurements, tibia length and cannon length, were the most repeatable, followed by the two

Table 19

Degree of repeatability of live measurements recorded by the author.

From duplicated readings taken on the 1956-born age group in both breeds at 6 months of age.

Girth	0.7176
Body length	0.8920
Pelvis length	0.9066
Pelvis width	0.9105
Cannon length	0.9821
Leg length	0.7892
Tibia length	0.9830

pelvis measurements and body length. Leg length was much less accurate and the least accurate of all was girth. The latter measurement was difficult to repeat due to external wool cover and to the softness of the actual flesh, a difference in pressure on the cord resulting in a difference in reading. Leg length and body length were both multiple bone measurements and could to some extent vary with the stance of the animal.

1. Treatment period, 6 - 12 months.

(a) Total groups. The actual mean live measurements recorded at the start and end of the treatment period in each experimental year are shown in Tables 20, 20a and 20b. Total and percentage gains by each measurement over the treatment period are shown in Tables 21, 21a and 21b, while the percentage gains are illustrated in Figs. V, Va and Vb. Adjusted means from covariance analysis and the significance of differences between them are shown in Tables 22, 22a and 22b.

Born 1956. The gains which occurred over the treatment period in the S.C.C. H.P. group ranged from 10.5% in girth to 3.3% in cannon length, giving an average increase in size from the seven measurements of 7.0%. In the N.C.C. H.P. group the range was from 10.8% in girth to 2.6% in leg length giving an average increase of 7.2%. In the M.P. groups, the S.C.C. measurements ranged from a gain of 6.8% in leg length to a gain of 0.8% in cannon length, while the N.C.C. measurements ranged from a gain of 4.9% in tibia length to a loss of 1.3% in girth, giving average gains of 2.9% and 1.8% for S.C.C. and N.C.C. respectively. In the L.P. groups, the S.C.C. measurements ranged from a gain of 0.3% in leg length to a loss of 3.6% in girth, while the N.C.C. measurements ranged from a gain of 3.8% in tibia length to a loss of 7.0% in girth, giving average losses of 1.2% and 0.2% for S.C.C. and N.C.C. respectively.

All measurements showing losses over the treatment period are so on account of loss of flesh or fat cover and are therefore associated with either cessation of bone growth or very limited increase. Conversely, gains in

Table 20

Mean live measurements over treatment period (mms.)

Born 1956

	S.C.C.						N.C.C.					
	27 weeks			49 weeks			27 weeks			49 weeks		
	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.
Girth	678	671	674	749	687	650	709	711	726	785	702	675
Body length	579	576	579	620	593	579	586	603	615	640	620	600
Pelvis length	186	184	185	196	186	181	191	192	190	203	198	191
Pelvis width	146	146	147	161	148	144	150	154	154	164	158	151
Cannon length	120	118	119	124	119	119	125	126	125	131	127	128
Leg length	321	311	319	339	332	320	346	348	340	355	346	350
Tibia length	173	172	175	185	180	174	182	182	186	195	191	193

Table 20a

Mean live measurements over treatment period (mms.)

Born 1957

	S.C.C.						N.C.C.					
	22 weeks			49 weeks			22 weeks			49 weeks		
	H.P.	M.P.	Hill	H.P.	M.P.	Hill	H.P.	M.P.	Hill	H.P.	M.P.	Hill
Girth	676	672	669	748	672	633	706	702	707	782	714	663
Body length	571	591	582	624	591	575	603	601	599	652	610	585
Pelvis length	182	185	182	202	193	184	189	191	190	211	200	188
Pelvis width	140	140	141	157	146	141	143	143	142	160	149	139
Cannon length	112	114	113	120	120	117	124	124	123	134	129	127
Leg length	318	321	323	341	338	337	349	352	347	379	374	363
Tibia length	165	169	166	179	178	173	181	182	180	199	194	186

Table 20b

Mean live measurements over treatment period (mms.)

Born 1958

	S.C.C.				N.C.C.			
	25 weeks		49 weeks		25 weeks		49 weeks	
	Away	Hill	Away	Hill	Away	Hill	Away	Hill
Girth	644	638	673	638	653	651	688	656
Body length	573	576	613	583	587	593	627	608
Pelvis length	183	183	197	183	189	189	201	190
Pelvis width	139	138	151	139	144	145	156	147
Cannon length	113	115	122	120	122	122	133	126
Leg length	325	327	343	340	349	349	370	359
Tibia length	163	165	179	171	179	179	194	184

Table 21

Actual and percentage gain in mean live measurements over treatment period (27-49 weeks)

Born 1956

	S.C.C.						N.C.C.					
	H.P.		M.P.		L.P.		H.P.		M.P.		L.P.	
	Gain in mms.	%-age gain	Gain in mms.	%-age gain	Gain in mms.	%-age gain	Gain in mms.	%-age gain	Gain in mms.	%-age gain	Gain in mms.	%-age gain
Girth	71	10.5	16	2.4	-24	-3.6	76	10.8	-9	-1.3	-51	-7.0
Body length	41	7.1	17	3.0	0	0	54	9.2	17	2.8	-15	-2.4
Pelvis length	10	5.4	2	1.1	- 4	-2.2	12	6.3	6	3.1	1	0.5
Pelvis width	15	10.3	2	1.4	- 3	-2.0	14	9.3	4	2.6	- 3	-1.9
Cannon length	4	3.3	1	0.8	0	0	6	4.8	1	0.8	3	2.4
Leg length	18	5.6	21	6.8	1	0.3	9	2.6	-2	-0.6	10	2.9
Tibia length	12	6.9	8	4.7	- 1	-0.6	13	7.1	9	4.9	7	3.8
Mean % gain		7.0		2.9		-1.2		7.2		1.8		-0.2

Table 21a

Actual and percentage gain in mean live measurements over treatment period (22-49 weeks)

Born 1957

	S.C.C.						N.C.C.					
	H.P.		M.P.		Hill		H.P.		M.P.		Hill	
	Gain in mms.	%-age gain	Gain in mms.	%-age gain	Gain in mms.	%-age gain	Gain in mms.	%-age gain	Gain in mms.	%-age gain	Gain in mms.	%-age gain
Girth	72	10.7	0	0	-36	-5.4	76	10.8	12	1.7	-44	-6.2
Body length	53	9.3	0	0	- 7	-1.2	49	8.1	9	1.5	-14	-2.3
Pelvis length	20	11.0	8	4.3	2	1.1	22	11.6	9	4.7	- 2	-1.1
Pelvis width	17	12.1	6	4.3	0	0	17	11.9	6	4.2	- 3	-2.1
Cannon length	8	7.1	6	5.3	4	3.5	10	8.1	5	4.0	4	3.3
Leg length	23	7.2	17	5.3	14	4.3	30	8.6	22	6.3	16	4.6
Tibia length	14	8.5	9	5.3	7	4.2	18	9.9	12	6.6	6	3.3
Mean % gain		9.4		3.5		0.9		9.9		4.1		-0.1

Table 21b

Actual and percentage gain in mean live measurements over treatment period (25-49 weeks)

Born 1958

	S.C.C.				N.C.C.			
	Away		Hill		Away		Hill	
	Gain in mms.	%-age gain	Gain in mms.	%-age gain	Gain in mms.	%-age gain	Gain in mms.	%-age gain
Girth	29	4.5	0	0	35	5.4	5	0.8
Body length	40	7.0	7	1.2	40	6.8	15	2.5
Pelvis length	14	7.7	0	0	12	6.3	1	0.5
Pelvis width	12	8.6	1	0.7	12	8.3	2	1.4
Cannon length	9	8.0	5	4.3	11	9.0	4	3.3
Leg length	18	5.5	13	4.0	21	6.0	10	2.9
Tibia length	16	9.8	6	3.6	15	8.4	5	2.8
Mean % gain		7.3		2.0		7.2		2.0

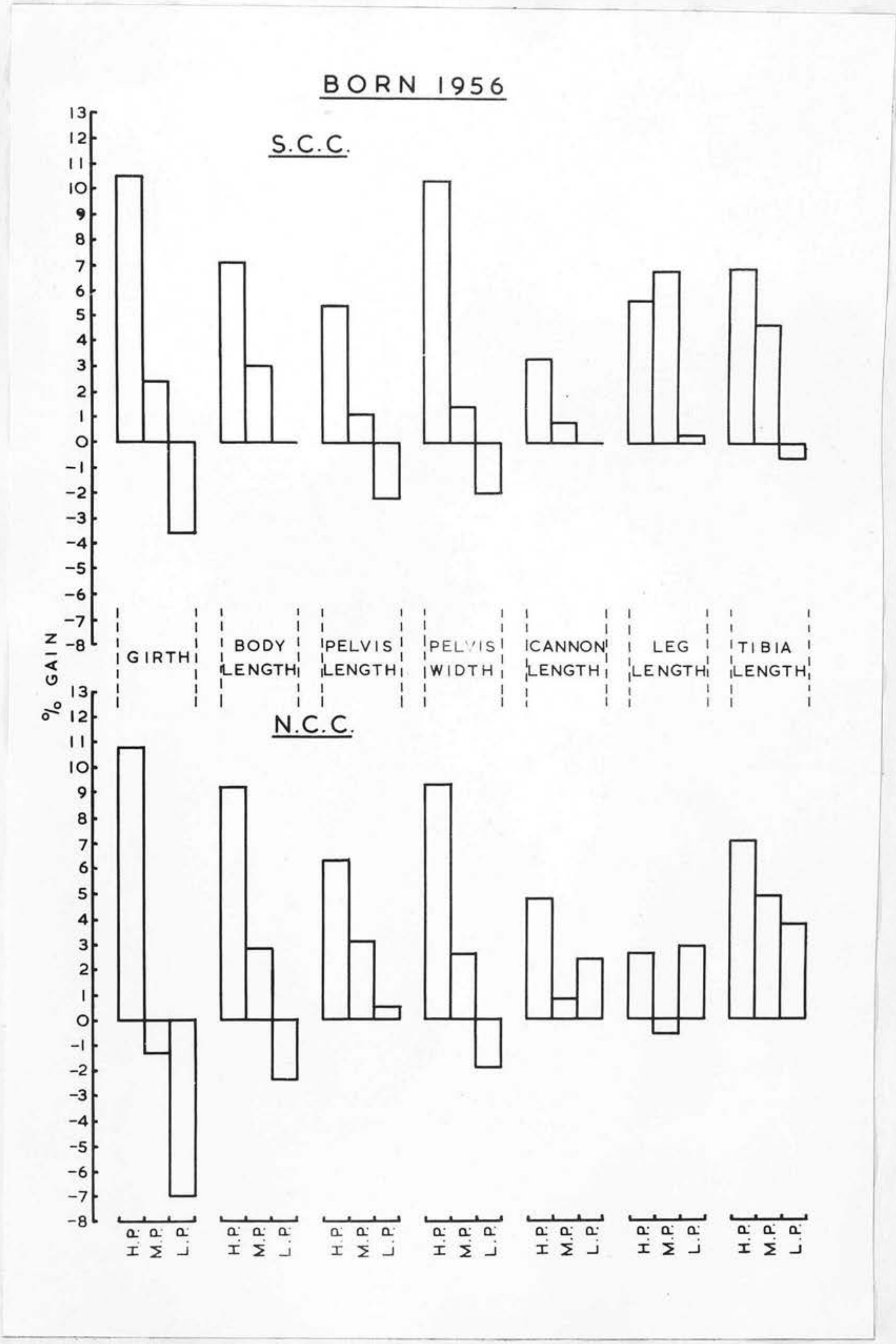

Fig. V. Percentage gain in mean live measurements over the treatment period.

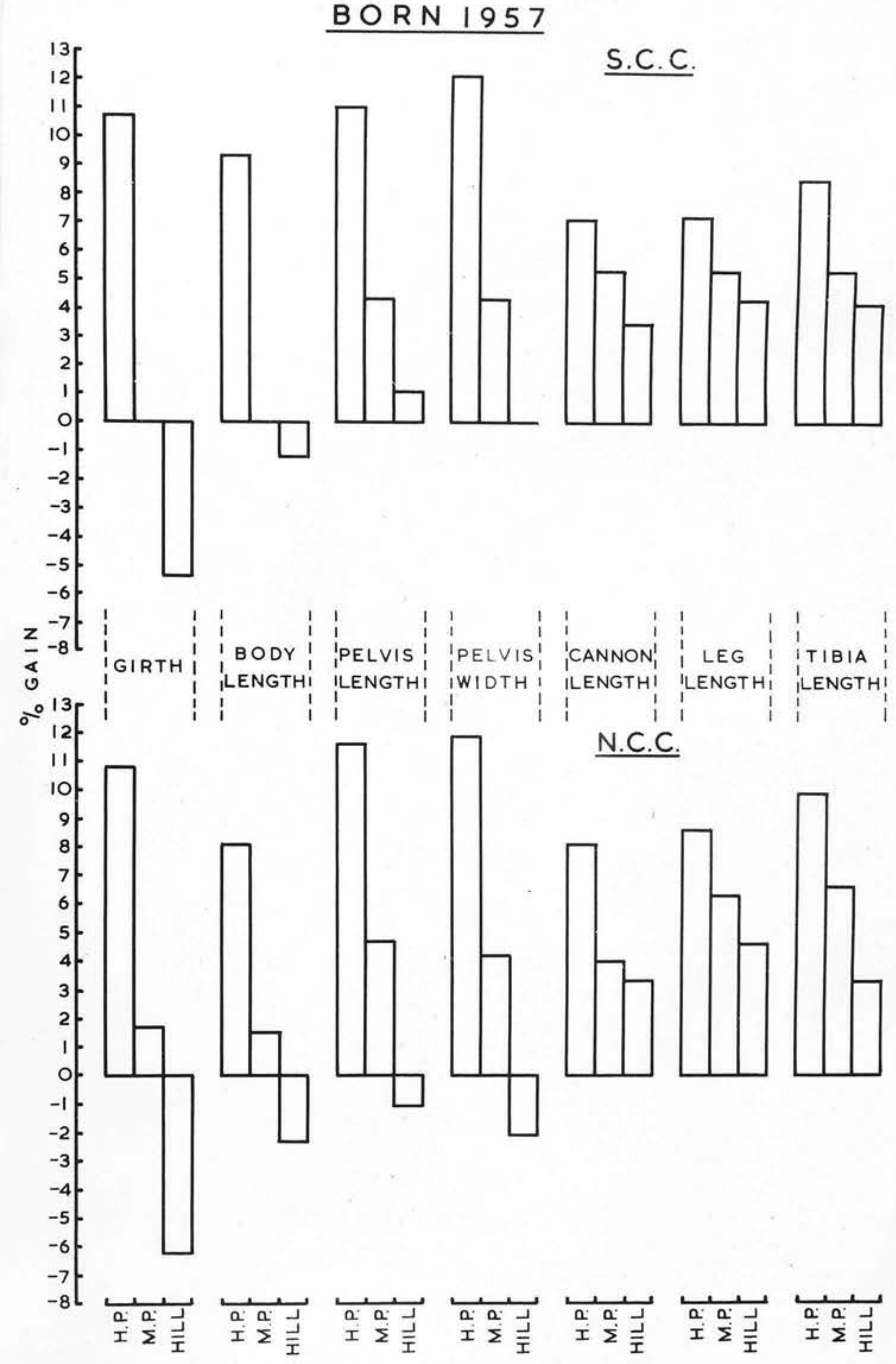

Fig. Va. Percentage gain in mean live measurements over the treatment period.

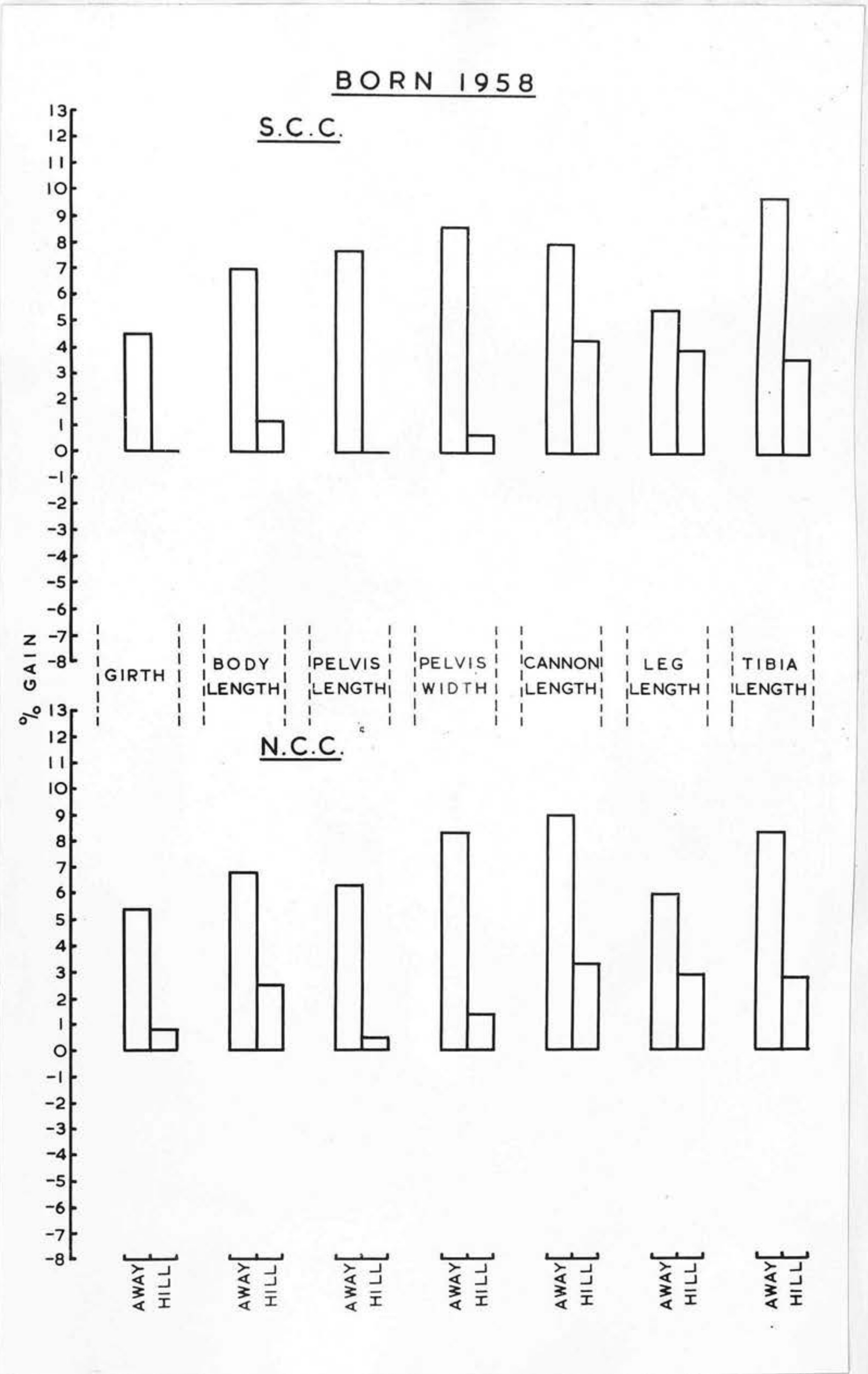

Fig. Vb. Percentage gain in mean live measurements over the treatment period.

certain measurements are the nett result of increase in bone growth plus flesh or fat cover and the better the feeding, as in the H.P. groups, the greater the cover is likely to be. However, in most of the measurements recorded, the depositions of flesh or fat were not considered to be of great dimensions relative to the underlying bone or bones. The only exception to this was the girth measurement which was very greatly affected by the condition of the animal. This is demonstrated in Fig. V. Pelvis width also appears to have been a little affected in this way.

In general, in both breeds this year, the body measurements responded greatly to a H.P. diet from 27 - 49 weeks of age but growth ceased on a L.P. diet. The three leg measurements, however, showed far less response on a H.P. diet and continued to grow on a L.P. diet, particularly in the N.C.C. breed. The M.P. diet resulted in a greater response in the growth of the tibia than was the case with the body measurements and cannon length. Leg length response in the two breeds resulting from treatment did not follow the pattern demonstrated by the other measurements. This is difficult to understand and is probably due to error in the technique of measuring.

Analysis of variance showed no significant differences in any of the measurements between the group means at the start of the treatment period. By the end of the treatment period at 49 weeks of age, covariance analysis showed all treatment group means to be significantly different in both breeds in the four body measurements, girth, body length, pelvis length and pelvis width.

In cannon length, however, although the H.P. groups in both breeds were significantly longer than both the M.P. and L.P. groups, the latter did not differ significantly. In leg length, the S.C.C. L.P. group was significantly shorter than the H.P. and M.P. groups, which did not differ significantly, while the N.C.C. M.P. group was also significantly shorter than its respective H.P. and L.P. groups, which again did not differ significantly. In tibia

Table 22

Adjusted mean live measurements and significance of differences between them over treatment period

Born 1956

		S.C.C. 49 weeks			N.C.C. 49 weeks		
		H.P.(13)+	M.P.(13)	L.P.(14)	H.P.(13)	M.P.(13)	L.P.(12)
Girth	(H.P.	747			789		
	(M.P.	***	688		***	705	
	(L.P.	***	**	651	***	**	668
Body length	(H.P.	620			646		
	(M.P.	**	595		*	620	
	(L.P.	***	*	578	***	*	594
Pelvis length	(H.P.	195.6			202.6		
	(M.P.	***	187.6		***	197.6	
	(L.P.	***	***	181.3	***	***	192.1
Pelvis width	(H.P.	161.0			166.4		
	(M.P.	***	148.7		***	157.0	
	(L.P.	***	**	142.9	***	**	149.8
Cannon length	(H.P.	123.2			131.3		
	(M.P.	***	120.3		***	126.7	
	(L.P.	***	NS	119.1	**	NS	128.3
Leg length	(H.P.	335			354		
	(M.P.	NS	337		**	344	
	(L.P.	***	***	319	NS	*	354
Tibia length	(H.P.	184.9			196.2		
	(M.P.	*	181.9		**	192.5	
	(L.P.	***	***	172.8	***	NS	190.5

+Number of animals in brackets.
*** = Significant at 0.1% level of probability.
** = " " 1% " " "
* = " " 5% " " "
NS = Non-significant.

Table 22a

Adjusted mean live measurements and significance of differences between them over treatment period

Born 1957

		S.C.C. 49 weeks H.P.(13)+	S.C.C. 49 weeks M.P.(12)	S.C.C. 49 weeks Hill(11)	N.C.C. 49 weeks H.P.(14)	N.C.C. 49 weeks M.P.(14)	N.C.C. 49 weeks Hill(14)
Girth	(H.P.	747			781		
	(M.P.	***	673		***	715	
	(Hill	***	**	633	***	***	662
Body length	(H.P.	617			650		
	(M.P.	**	587		***	611	
	(Hill	***	NS	574	***	***	586
Pelvis length	(H.P.	202.7			212.0		
	(M.P.	***	191.9		***	198.5	
	(Hill	***	***	183.9	***	***	187.8
Pelvis width	(H.P.	157.6			160.3		
	(M.P.	***	146.4		***	148.6	
	(Hill	***	**	140.8	***	***	139.1
Cannon length	(H.P.	120.5			133.6		
	(M.P.	NS	119.3		***	129.0	
	(Hill	**	*	116.9	***	*	127.1
Leg length	(H.P.	343			380		
	(M.P.	NS	338		*	372	
	(Hill	NS	NS	335	***	*	365
Tibia length	(H.P.	180.1			198.2		
	(M.P.	NS	176.8		NS	193.4	
	(Hill	*	NS	173.7	***	**	186.6

+Number of animals in brackets.

*** = Significant at 0.1% level of probability.

** = " " 1% " " "

* = " " 5% " " "

NS = Non-significant.

Table 22b

Adjusted mean live measurements and significance of differences between them over treatment period

Born 1958

		S.C.C. 49 weeks		N.C.C. 49 weeks	
		Away(14)+	Hill(13)	Away(15)	Hill(15)
Girth	(Away	671		687	
	(Hill	***	640	***	656
Body length	(Away	613		629	
	(Hill	***	582	***	607
Pelvis length	(Away	196.5		201.4	
	(Hill	***	183.2	***	190.1
Pelvis width	(Away	150.1		156.9	
	(Hill	***	139.3	***	146.3
Cannon length	(Away	122.9		132.0	
	(Hill	***	119.1	***	126.3
Leg length	(Away	344		370	
	(Hill	NS	339	***	359
Tibia length	(Away	179.3		193.9	
	(Hill	***	170.4	***	184.1

+Number of animals in brackets.

*** = Significant at 0.1% level of probability.

NS = Non-significant.

length, all the S.C.C. group means differed significantly but only the N.C.C. H.P. group was significantly longer than both the M.P. and L.P. groups, which did not differ significantly.

<u>Born 1957</u>. The gains which occurred over the treatment period in the S.C.C. H.P. group ranged from 12.1% in pelvis width to 7.1% in cannon length, giving an average increase in size from the seven measurements of 9.4%. In the N.C.C. H.P. group, the range was very similar, from 11.9% in pelvis width to 8.1% in cannon length and body length, giving an average increase of 9.9%. In the M.P. groups, the S.C.C. measurements ranged from a gain of 5.3% in the three leg measurements to no change in girth and body length, while the N.C.C. measurements ranged from a gain of 6.6% in tibia length to a gain of 1.5% in body length, giving average gains of 3.5% and 4.1% for S.C.C. and N.C.C. respectively. In the Hill groups, the S.C.C. measurements ranged from a gain of 4.3% in leg length to a loss of 5.4% in girth, while the N.C.C. measurements ranged very similarly from a gain of 4.6% in leg length to a loss of 6.2% in girth, giving an average gain in the S.C.C. group of 0.9% and an average loss in the N.C.C. group of 0.1%.

As in 1956, in both breeds the girth of animals wintered on the hill as a L.P., was greatly reduced due to loss of flesh and fat cover (see Fig. Va). The N.C.C. Hill group also suffered greater losses in the body measurements than the S.C.C. Hill group, probably due to the former's greater size. The greater differential response due to treatment in the body measurements relative to the leg measurements as present in 1956 was repeated this year, the H.P. diet causing greater growth in the body measurements than in the leg measurements with the Hill diet stopping body growth but only retarding leg growth. In general, the M.P. diet resulted in a greater response in the growth of the leg measurements than the body measurements, with the exception of the N.C.C. cannon length whose response was, however, very little less than that of the two pelvis measurements.

Analysis of variance showed no significant differences in any of the measurements between the group means at the start of the treatment period. By the end of the treatment period at 49 weeks of age, covariance analysis showed all the N.C.C. treatment group means to be significantly different in six out of the seven measurements. In tibia length, only the Hill group was significantly shorter than both the H.P. and M.P. groups, which did not differ significantly.

In the S.C.C. breed, covariance analysis at 49 weeks of age showed all treatment group means to be significantly different only in girth, pelvis length and pelvis width. In body length, the H.P. group was significantly longer than both the M.P. and Hill groups, which did not differ significantly. In the leg measurements, the treatments created very few significant differences between the groups. Only the differences between the H.P. and Hill groups in cannon length and tibia length and between the M.P. and Hill groups in cannon length only, were significant.

Born 1958. The gains which occurred over the treatment period in the S.C.C. Away group ranged from 9.8% in tibia length to 4.5% in girth, giving an average increase in size from the seven measurements of 7.3%. In the N.C.C. Away group, the range was from 9.0% in cannon length to 5.4% in girth, giving an average increase of 7.2%. In the Hill groups, the S.C.C. measurements ranged from a gain of 4.3% in cannon length to no change in girth and pelvis length, while the N.C.C. measurements ranged from a gain of 3.3% in cannon length to a gain of 0.5% in pelvis length, giving average gains of 2.0% in both breeds.

In this year, the girth measurement has been least affected by both treatments. Unlike the previous two years the high plane rearing as described by the Away wintering caused greater growth in the leg measurements, with the exception of leg length itself, than in the body measurements, suggesting that the Away wintering was nearer a mid plane than a high plane. The Hill wintering, however, had a similar effect to the previous two years L.P. and Hill treatments, with growth being greatly retarded in the body measurements and only partially retarded in the leg measurements.

Analysis of variance showed no significant differences in any of the measurements between the group means at the start of the treatment period. By the end of the treatment period at 49 weeks of age, covariance analysis showed the N.C.C. treatment group means to be significantly different in all measurements. In the S.C.C. breed, the treatment group means were significantly different in six out of the seven measurements; only in leg length was the difference not significant.

(b) Heavy and light hoggs prior to treatment. The actual mean live measurements recorded at the start and end of the treatment period in each experimental year are tabulated in Tables 23, 23a and 23b. Total and percentage gains by each measurement in both weight classes over the treatment period are given in Tables 24, 24a and 24b, while the percentage gains are illustrated in Figs. VI, VIa and VIb. Adjusted means from covariance analysis and the significance of differences between them in each weight class are shown in Tables 25, 25a and 25b.

For the purpose of this study, growth, as depicted by live measurement increase, has been examined in the heavy and light animals in each treatment group at the start of the experiment, on the assumption that the heavy animals are also the largest and the light the smallest. That this is completely so is not certain and possibly a better approach would have been to study the effects of treatment on the large and small animals as depicted by live measurement and not on the heavy and light. However, weight is one of the main criteria used in the initial selection of keeping ewe lambs and it has therefore been used in this study on relative growth.

Born 1956. In the S.C.C. H.P. group, the gains which occurred in the light sub-group ranged from 13.7% in pelvis width to 4.3% in cannon length compared with the smaller gains in the heavy sub-group which ranged from 8.6% in girth

Table 23

Mean live measurements over treatment period of heavy and light hoggs prior to treatment (mms.)

Born 1956

		S.C.C.						N.C.C.					
		27 weeks			49 weeks			27 weeks			49 weeks		
		H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.
Girth	(Heavy	697	697	692	757	708	653	737	731	742	813	722	688
	(Light	657	650	648	739	669	647	691	698	714	767	689	666
Body length	(Heavy	593	588	581	629	603	581	611	625	632	655	646	605
	(Light	563	566	576	611	585	575	570	589	603	630	604	596
Pelvis length	(Heavy	192	188	186	200	192	183	195	199	192	205	204	193
	(Light	179	180	184	193	182	179	190	187	188	201	195	190
Pelvis width	(Heavy	151	150	151	163	153	146	155	160	159	169	160	156
	(Light	139	142	142	158	144	140	147	150	150	161	157	147
Cannon length	(Heavy	125	120	121	128	122	121	129	130	126	134	130	129
	(Light	115	116	116	120	117	117	123	123	125	129	125	128
Leg length	(Heavy	327	317	321	348	336	321	347	359	346	360	359	356
	(Light	314	307	316	329	328	318	345	341	335	353	338	346
Tibia length	(Heavy	177	177	177	189	186	177	186	189	187	201	196	194
	(Light	168	167	171	180	176	171	181	178	185	192	188	193

Table 23a

Mean live measurements over treatment period of heavy and light hoggs prior to treatment (mms.)

Born 1957

		S.C.C.						N.C.C.					
		22 weeks			49 weeks			22 weeks			49 weeks		
		H.P.	M.P.	Hill	H.P.	M.P.	Hill	H.P.	M.P.	Hill	H.P.	M.P.	Hill
Girth	Heavy	686	688	690	735	688	649	718	716	721	776	721	672
	Light	660	660	640	769	660	605	697	683	696	786	705	656
Body length	Heavy	584	618	596	631	607	584	617	613	602	661	616	589
	Light	549	571	561	549	580	560	593	584	596	646	603	583
Pelvis length	Heavy	187	189	186	205	199	187	193	193	193	213	202	190
	Light	174	182	177	198	189	178	186	188	187	210	197	186
Pelvis width	Heavy	145	144	143	159	151	143	148	145	147	162	150	142
	Light	134	137	139	155	142	139	139	141	138	159	148	136
Cannon length	Heavy	114	117	115	120	124	117	126	124	125	135	130	129
	Light	109	111	112	119	117	118	123	124	121	134	129	125
Leg length	Heavy	321	326	330	345	350	341	357	356	352	385	378	368
	Light	314	318	313	335	330	331	343	348	344	375	369	359
Tibia length	Heavy	166	175	168	179	185	173	185	186	183	205	199	188
	Light	163	165	162	180	174	174	179	177	177	194	188	184

Table 23b

Mean live measurements over treatment period of heavy and light hoggs prior to treatment (mms.)

Born 1958

		S.C.C.				N.C.C.			
		25 weeks		49 weeks		25 weeks		49 weeks	
		Away	Hill	Away	Hill	Away	Hill	Away	Hill
Girth	(Heavy	655	656	682	656	672	678	706	669
	(Light	623	618	656	618	624	634	662	647
Body length	(Heavy	576	582	616	590	593	600	631	619
	(Light	567	568	607	574	579	588	623	601
Pelvis length	(Heavy	185	187	199	186	192	195	203	194
	(Light	179	179	193	180	184	186	199	188
Pelvis width	(Heavy	142	141	154	141	149	150	159	150
	(Light	134	134	145	136	138	142	152	145
Cannon length	(Heavy	113	118	122	122	124	125	133	128
	(Light	113	113	121	118	120	119	131	125
Leg length	(Heavy	327	328	344	343	353	359	371	366
	(Light	322	326	341	336	343	342	368	354
Tibia length	(Heavy	163	168	179	174	182	184	195	190
	(Light	162	162	177	168	174	175	192	180

Table 24

Actual and percentage gain in mean live measurements over treatment period of heavy and light hoggs prior to treatment (27-49 weeks).

Born 1956

		S.C.C.						N.C.C.					
		Actual gain in mms.			Percentage gain			Actual gain in mms.			Percentage gain		
		H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.
Girth	(Heavy	60	11	-39	8.6	1.6	-5.6	76	- 9	-54	10.3	-1.2	-7.3
	(Light	82	19	- 1	12.5	2.9	-0.2	76	- 9	-48	11.0	-1.3	-6.7
Body length	(Heavy	36	15	0	6.1	2.6	0	44	21	-27	7.2	3.4	-4.3
	(Light	48	19	- 1	8.5	3.4	-0.2	60	15	- 7	10.5	2.5	-1.2
Pelvis length	(Heavy	8	4	- 3	4.2	2.1	-1.6	10	5	1	5.1	2.5	0.5
	(Light	14	2	- 5	7.8	1.1	-2.7	11	8	2	5.8	4.3	1.1
Pelvis width	(Heavy	12	3	- 5	7.9	2.0	-3.3	14	0	- 3	9.0	0	-1.9
	(Light	19	2	- 2	13.7	1.4	-1.4	14	7	- 3	9.5	4.7	-2.0
Cannon length	(Heavy	3	2	0	2.4	1.7	0	5	0	3	3.9	0	2.4
	(Light	5	1	1	4.3	0.9	0.9	6	2	3	4.9	1.6	2.4
Leg length	(Heavy	21	19	0	6.4	6.0	0	13	0	10	3.7	0	2.9
	(Light	15	21	2	4.8	6.8	0.6	8	- 3	11	2.3	-0.9	3.3
Tibia length	(Heavy	12	9	0	6.8	5.1	0	15	7	7	8.1	3.7	3.7
	(Light	12	9	0	7.1	5.4	0	11	10	8	6.1	5.6	4.3
Mean % gain	(Heavy				6.1	3.0	-1.5				6.8	1.2	-0.6
	(Light				8.4	3.1	-0.4				7.2	2.4	0.2

Table 24a

Actual and percentage gain in mean live measurements over treatment period of heavy and light hoggs prior to treatment (22-49 weeks)

Born 1957

		S.C.C.						N.C.C.					
		Actual gain in mms.			Percentage gain			Actual gain in mms.			Percentage gain		
		H.P.	M.P.	Hill	H.P.	M.P.	Hill	H.P.	M.P.	Hill	H.P.	M.P.	Hill
Girth	(Heavy	49	0	-41	7.1	0	-5.9	58	5	-49	8.1	0.7	-6.8
	(Light	109	0	-35	16.5	0	-5.5	89	22	-40	12.8	3.2	-5.7
Body length	(Heavy	47	-11	-12	8.0	-1.8	-2.0	44	3	-13	7.1	0.5	-2.2
	(Light	0	9	- 1	0	1.6	-0.2	53	19	-13	8.9	3.3	-2.2
Pelvis length	(Heavy	18	10	1	9.6	5.3	0.5	20	9	- 3	10.4	4.7	-1.6
	(Light	24	7	1	13.8	3.8	0.6	24	9	- 1	12.9	4.8	-0.5
Pelvis width	(Heavy	14	7	0	9.7	4.9	0	14	5	- 5	9.5	3.4	-3.4
	(Light	21	5	0	15.7	3.6	0	20	7	- 2	14.4	5.0	-1.4
Cannon length	(Heavy	6	7	2	5.3	6.0	1.7	9	6	4	7.1	4.8	3.2
	(Light	10	6	6	9.2	5.4	5.4	11	5	4	8.9	4.0	3.3
Leg length	(Heavy	24	24	11	7.5	7.4	3.3	28	22	16	7.8	6.2	4.5
	(Light	21	12	18	6.7	3.8	5.8	32	21	15	9.3	6.0	4.4
Tibia length	(Heavy	13	10	5	7.8	5.7	3.0	20	13	5	10.8	7.0	2.7
	(Light	17	9	12	10.4	5.5	7.4	15	11	7	8.4	6.2	4.0
Mean % gain	(Heavy				7.9	3.9	0.1				8.7	3.9	-0.5
	(Light				10.3	3.4	1.9				10.8	4.6	0.3

Table 24b

Actual and percentage gain in mean live measurements over treatment period of heavy and light hoggs prior to treatment (25-49 weeks)

Born 1958

		S.C.C. Actual gain in mms. Away	S.C.C. Actual gain in mms. Hill	S.C.C. Percentage gain Away	S.C.C. Percentage gain Hill	N.C.C. Actual gain in mms. Away	N.C.C. Actual gain in mms. Hill	N.C.C. Percentage gain Away	N.C.C. Percentage gain Hill
Girth	(Heavy	27	0	4.1	0	34	- 9	5.1	-1.3
	(Light	33	0	5.3	0	38	13	6.1	2.1
Body length	(Heavy	40	8	6.9	1.4	38	19	6.4	3.2
	(Light	40	6	7.1	1.1	44	13	7.6	2.2
Pelvis length	(Heavy	14	- 1	7.6	-0.5	11	- 1	5.7	-0.5
	(Light	14	1	7.8	0.6	15	2	8.2	1.1
Pelvis width	(Heavy	12	0	8.5	0	10	0	6.7	0
	(Light	11	2	8.2	1.5	14	3	10.1	2.1
Cannon length	(Heavy	9	4	8.0	3.4	9	3	7.3	2.4
	(Light	8	5	7.1	4.4	11	6	9.2	5.0
Leg length	(Heavy	17	15	5.2	4.6	18	7	5.1	1.9
	(Light	19	10	5.9	3.1	25	12	7.3	3.5
Tibia length	(Heavy	16	6	9.8	3.6	13	6	7.1	3.3
	(Light	15	6	9.3	3.7	18	5	10.3	2.9
Mean % gain	(Heavy			7.2	1.8			6.2	1.3
	(Light			7.2	2.1			8.4	2.7

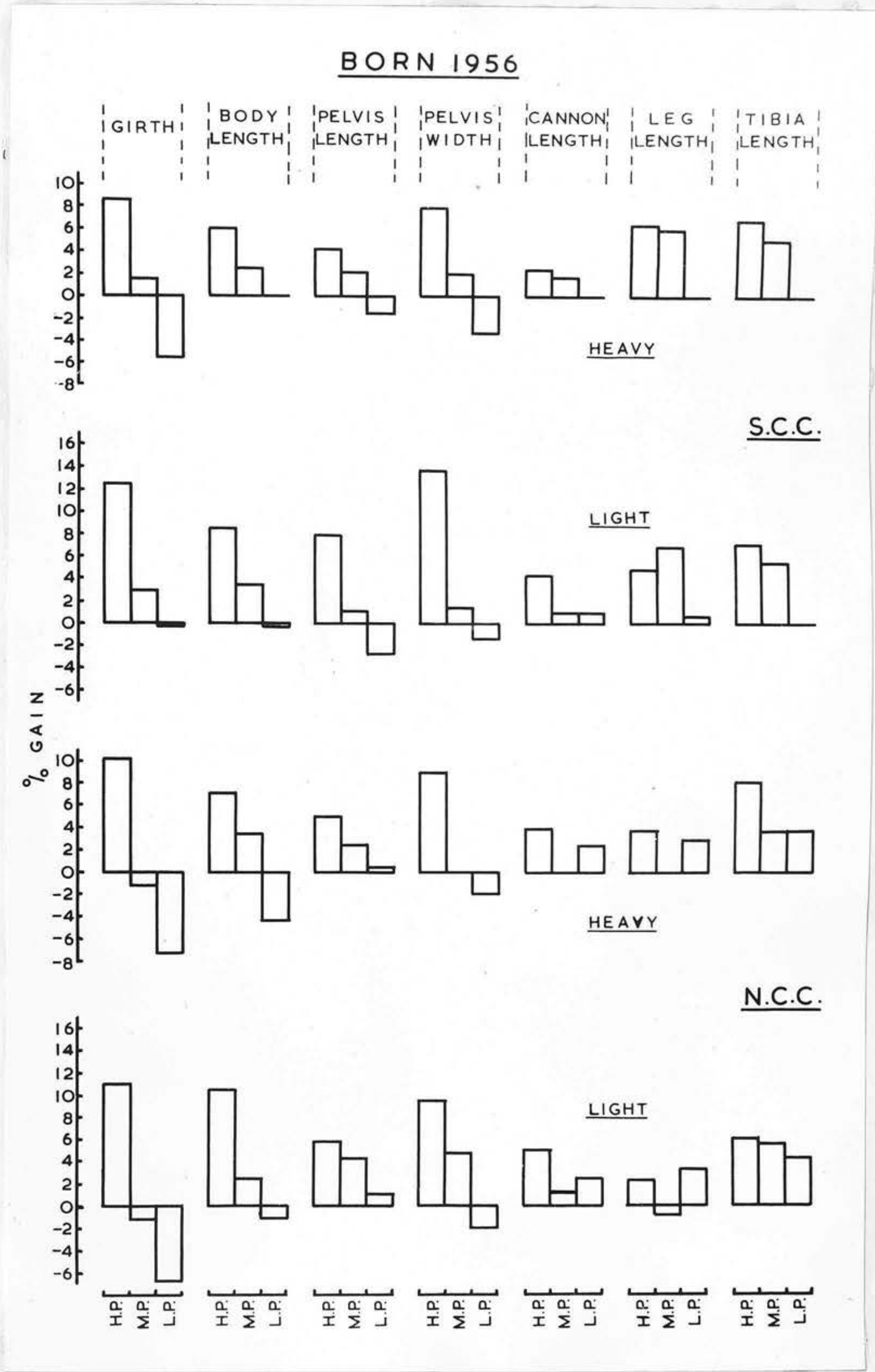

Fig. VI. Percentage gain in mean live measurements over the treatment period of heavy and light hoggs prior to treatment.

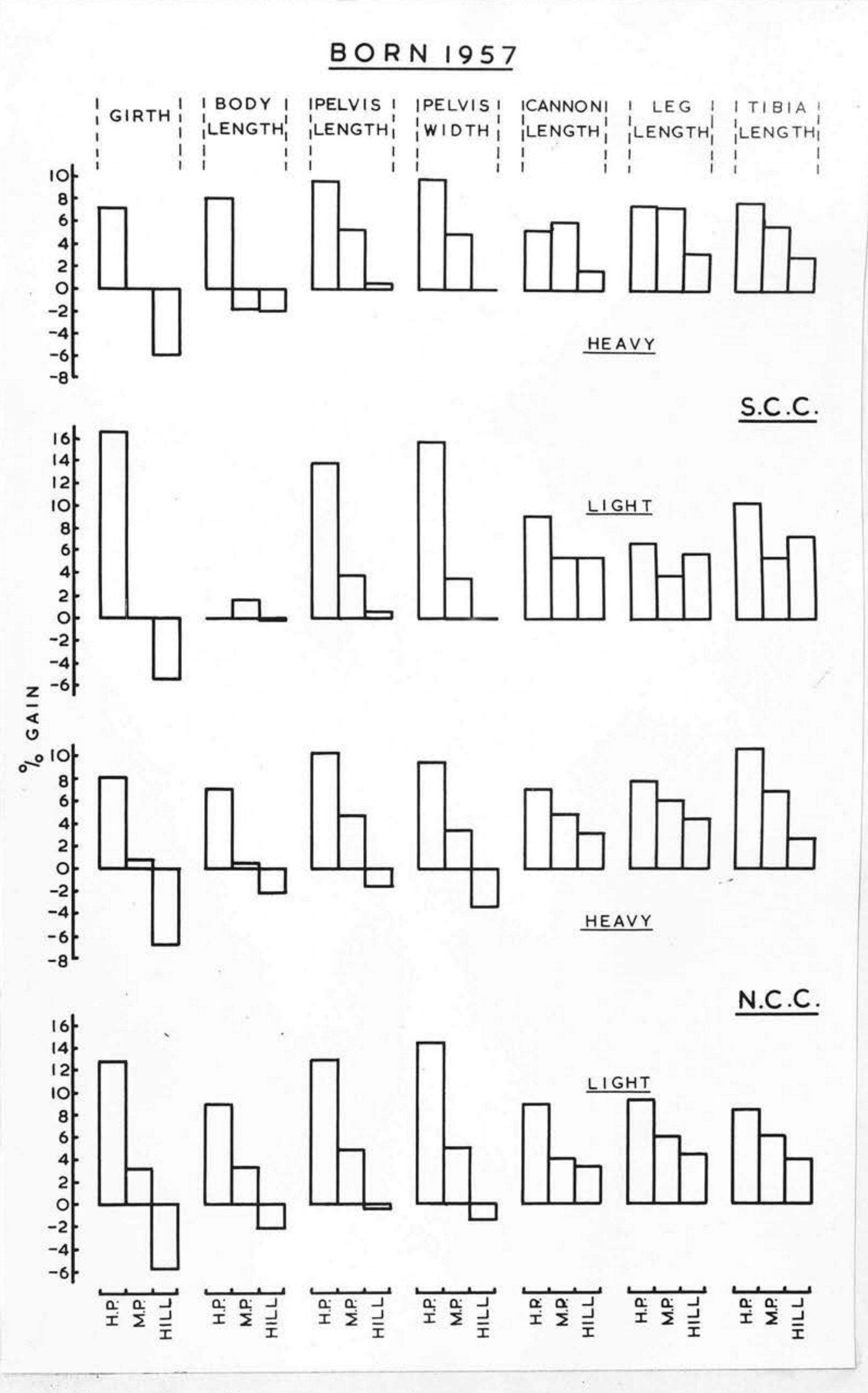

Fig. VIa. Percentage gain in mean live measurements over the treatment period of heavy and light hoggs prior to treatment.

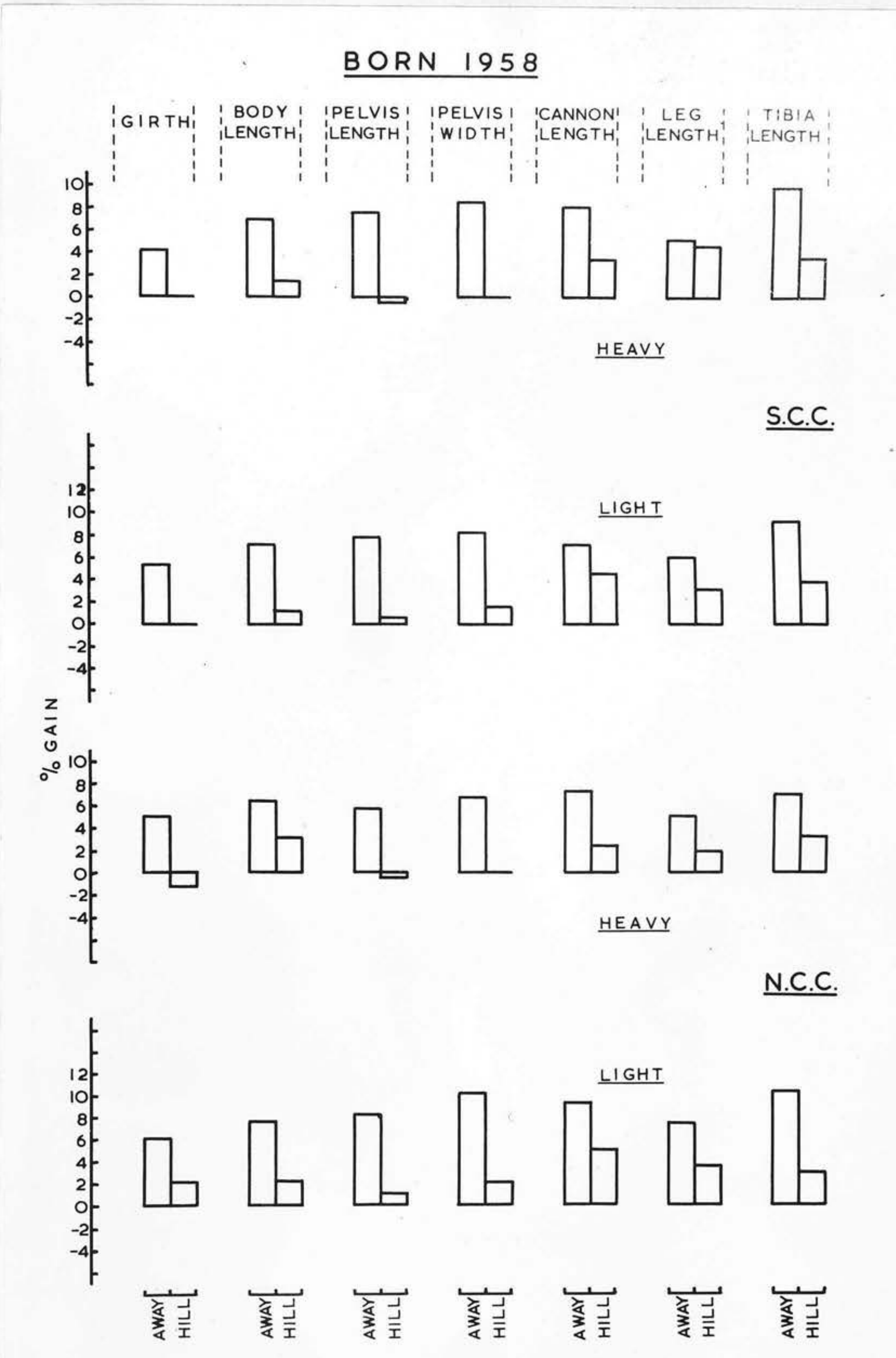

Fig. VIb. Percentage gain in mean live measurements over the treatment period of heavy and light hoggs prior to treatment.

to 2.4% in cannon length. The seven measurements gave an average increase in size of 8.4% and 6.1% for light and heavy respectively. The N.C.C. H.P. light sub-group gains ranged from 11.0% in girth to 2.3% in leg length, while the heavy sub-group gains ranged similarly from 10.3% in girth to 3.7% in leg length, giving average gains of 7.2% and 6.8% respectively. In the S.C.C. M.P. light sub-group, the gains ranged from 6.8% in leg length to 0.9% in cannon length, while in the heavy sub-group they ranged from 6.0% in leg length to 1.6% in girth, giving similar average gains of 3.1% and 3.0% respectively. In the N.C.C. M.P. light sub-group, the range was from a gain of 5.6% in tibia length to a loss of 1.3% in girth, while in the heavy sub-group the range was similar, from a gain of 3.7% in tibia length to a loss of 1.2% in girth. These gave average gains of 2.4% and 1.2% for light and heavy respectively. The S.C.C. L.P. light sub-group ranged from a gain of 0.9% in cannon length to a loss of 2.7% in pelvis length while the heavy sub-group ranged from no change in four of the measurements to a loss of 5.6% in girth, giving average losses of 0.4% and 1.5% respectively. In the N.C.C. L.P. light sub-group, the range was from a gain of 4.3% in tibia length to a loss of 6.7% in girth, while in the heavy sub-group the range was similar, from a gain of 3.7% in tibia length to a loss of 7.3% in girth, giving an average gain of 0.2% in the light animals and an average loss of 0.6% in the heavy.

In the S.C.C. H.P. group, the response of the four body measurements and cannon length over the treatment period was relatively greater in the light animals than in the heavy but in tibia length there was little difference in response between the two weight classes. Leg length response being smaller in the light animals was responsible for the total H.P. group gaining relatively less than the M.P. in this measurement. In the S.C.C. M.P. group there was very little difference between the two weight classes in the relative responses of any of the measurements. In the S.C.C. L.P. group only in girth was there any notable difference between the weight classes, the heavy animals losing considerably more than the light.

The N.C.C. H.P. group did not quite emulate the S.C.C. H.P., both weight classes exhibiting similar relative increases in most of the measurements, only body length being greater and tibia length slightly shorter in the light animals. In the N.C.C. M.P. group, pelvis width was the only measurement to show any sizable difference in response, being greater in the light animals, while pelvis length, cannon length and tibia length were also very slightly greater in this weight class. In the N.C.C. L.P. group only in body length was there any difference between the weight classes, the heavy animals losing more tissue cover than the light.

Analysis of variance showed no significant differences in any of the measurements between the sub-group means in either weight class at the start of the treatment period. By the end of the treatment period at 49 weeks of age, covariance analysis showed in the S.C.C. breed that only in pelvis length did the treatments create significant differences between all three sub-groups in both weight classes. In girth, pelvis width and cannon length only in the heavy weight class were all sub-groups significantly different, in the light weight class the treatments failed to create a significant difference between the M.P. and L.P. sub-groups. In leg length and tibia length in both weight classes the L.P. sub-groups were significantly shorter than their respective H.P. and M.P. sub-groups which were not significantly different. In body length the only significant differences were, in the heavy weight class, between the H.P. and L.P. sub-groups and in the light weight class, between the H.P. and each of the other two sub-groups.

In the N.C.C. breed at 49 weeks, as in the S.C.C. breed, only in pelvis length did the treatments create significant differences between all three sub-groups in both weight classes. This would also have been the case in pelvis width but for the M.P. heavy animals which failed to increase during this period and remained non-significantly different from those in the L.P. In leg length

Table 25

Heavy and light hoggs prior to treatment. Adjusted mean live measurements and significance of differences between them over treatment period.

Born 1956

		S.C.C. 49 weeks Heavy H.P.(7)+	S.C.C. Heavy M.P.(6)	S.C.C. Heavy L.P.(8)	S.C.C. Light H.P.(6)	S.C.C. Light M.P.(7)	S.C.C. Light L.P.(6)	N.C.C. 49 weeks Heavy H.P.(5)	N.C.C. Heavy M.P.(5)	N.C.C. Heavy L.P.(5)	N.C.C. Light H.P.(8)	N.C.C. Light M.P.(8)	N.C.C. Light L.P.(7)
Girth	(H.P.	756			739			813			771		
	(M.P.	*	707		***	669		***	726		***	690	
	(L.P.	***	**	655	***	NS	647	***	NS	684	***	NS	661
Body length	(H.P.	624			615			655			635		
	(M.P.	NS	602		*	587		NS	646		*	604	
	(L.P.	*	NS	586	**	NS	570	*	*	605	*	NS	591
Pelvis length	(H.P.	197.0			194.6			205.8			200.9		
	(M.P.	*	191.9		***	183.3		*	200.9		*	196.0	
	(L.P.	***	**	185.5	***	*	175.5	**	*	195.9	***	**	190.0
Pelvis width	(H.P.	163.0			159.8			172.9			162.7		
	(M.P.	*	153.9		***	143.0		***	157.4		*	156.3	
	(L.P.	***	*	146.2	***	NS	139.4	***	NS	154.7	***	***	146.5
Cannon length	(H.P.	125.9			120.6			133.8			129.9		
	(M.P.	*	123.9		***	116.4		*	128.9		*	125.5	
	(L.P.	***	**	121.5	***	NS	116.6	NS	NS	131.1	*	NS	126.3
Leg length	(H.P.	343			327			362			349		
	(M.P.	NS	341		NS	333		NS	354		NS	337	
	(L.P.	**	**	322	*	*	314	NS	NS	359	NS	NS	350
Tibia length	(H.P.	188.9			180.4			202.2			192.5		
	(M.P.	NS	185.7		NS	177.4		**	195.0		NS	190.9	
	(L.P.	***	***	177.0	***	**	168.2	**	NS	193.4	NS	NS	188.5

+Number of animals in brackets.
*** = Significant at 0.1% level of probability.
** = " " 1% " " "
* = Significant at 5% level of probability.
NS = Non-significant.

Table 25a.

Heavy and light hoggs prior to treatment. Adjusted mean live measurements and significance of differences between them over treatment period.

Born 1957

		S.C.C. 49 weeks						N.C.C. 49 weeks					
		Heavy			Light			Heavy			Light		
		H.P.(8)+	M.P.(5)	Hill (7)	H.P.(5)	M.P.(7)	Hill (4)	H.P.(6)	M.P.(8)	Hill(6)	H.P.(8)	M.P.(6)	Hill(8)
Girth	H.P.	737			769			769			785		
	M.P.	**	688		***	660		*	722		***	709	
	Hill	***	**	647	***	*	604	***	*	671	***	***	655
Body length	H.P.	635			612			660			646		
	M.P.	NS	600		**	580		***	616		***	601	
	Hill	*	NS	584	***	NS	560	***	*	590	***	NS	583
Pelvis length	H.P.	204.7			200.3			213.2			210.9		
	M.P.	*	197.2		***	186.4		***	201.8		***	195.4	
	Hill	***	*	187.8	***	**	179.2	***	***	190.1	***	***	185.8
Pelvis width	H.P.	158.3			156.7			160.8			159.2		
	M.P.	**	150.5		***	142.0		**	151.3		***	146.3	
	Hill	***	*	143.8	***	NS	137.1	***	**	141.6	***	***	136.9
Cannon length	H.P.	121.0			120.6			133.6			133.3		
	M.P.	NS	122.5		**	116.5		NS	130.7		***	127.7	
	Hill	**	**	117.7	**	NS	115.9	*	NS	129.0	***	NS	125.7
Leg length	H.P.	347			336			384			376		
	M.P.	NS	349		NS	329		NS	377		*	367	
	Hill	*	*	338	NS	NS	332	NS	NS	371	***	*	359
Tibia length	H.P.	180.5			180.2			204.9			192.8		
	M.P.	NS	180.6		**	173.1		NS	197.9		NS	188.8	
	Hill	NS	NS	174.0	*	NS	173.9	***	*	189.2	**	*	184.2

+Number of animals in brackets.
*** = Significant at the 0.1% level of probability.
** = " " " 1% " " "
* = Significant at the 5% level of probability.
NS = Non-significant.

Table 25b

Heavy and light hoggs prior to treatment. Adjusted mean live measurements and significance of differences between them over treatment period.

		Born 1958							
		S.C.C. 49 weeks				N.C.C. 49 weeks			
		Heavy		Light		Heavy		Light	
		Away(9)+	Hill(7)	Away(5)	Hill(6)	Away(9)	Hill(6)	Away(6)	Hill(9)
Girth	(Away	682		655		707		665	
	(Hill	NS	656	***	619	*	667	NS	645
Body length	(Away	619		607		631		627	
	(Hill	***	588	*	574	NS	619	*	598
Pelvis length	(Away	199.0		192.5		203.8		199.6	
	(Hill	***	185.5	***	180.3	***	192.7	***	187.1
Pelvis width	(Away	154.7		144.8		159.6		155.3	
	(Hill	***	141.7	***	136.0	***	149.3	***	143.4
Cannon length	(Away	124.1		120.9		133.6		130.7	
	(Hill	*	119.7	NS	118.2	***	127.6	**	124.9
Leg length	(Away	345		343		373		368	
	(Hill	NS	343	NS	334	*	363	**	354
Tibia length	(Away	180.8		177.1		196.1		192.2	
	(Hill	NS	172.1	*	168.1	***	188.2	***	180.1

+Number of animals in brackets.
*** = Significant at 0.1% level of probability.
** = " " 1% " " "
* = " " 5% " " "
NS = Non-significant.

none of the treatment differences were significant in either weight class, while in tibia length the only significant difference was in the heavy weight class, the H.P. animals being significantly longer than those of both the other two treatments. In girth, both the H.P. sub-groups were significantly greater than their respective M.P. and L.P. sub-groups which in neither weight class were significantly different. This was also the case in the light weight class with body length and cannon length but in the former the M.P. heavy sub-group had grown so much that it was almost as long as the H.P. and significantly longer than the L.P. In cannon length, the L.P. heavy sub-group, being slightly greater than the M.P., was not significantly different from either of the other two sub-groups.

Born 1957. In the S.C.C. H.P. group, the gains which occurred in the light sub-group ranged from 16.5% in girth to no change in body length compared with the smaller gains in the heavy sub-group which ranged from 9.7% in pelvis width to 5.3% in cannon length. The seven measurements gave an average increase in size of 10.3% and 7.8% for light and heavy respectively. The N.C.C. H.P. light sub-group gains ranged from 14.4% in pelvis width to 8.4% in tibia length, while the heavy sub-group gains ranged from 10.8% in tibia length to 7.1% in body length and cannon length, giving average gains of 10.8% and 8.7% respectively.

The S.C.C. M.P. light sub-group gains ranged from 5.5% in tibia length to no change in girth while in the heavy sub-group the range was from a gain of 7.4% in leg length to a loss of 1.8% in body length, giving similar average gains of 3.4% and 3.9% respectively. The N.C.C. M.P. light sub-group gains ranged from 6.2% in tibia length to 3.2% in girth, while the heavy sub-group gains ranged from 7.0% in tibia length to 0.5% in body length, giving average gains of 4.6% and 3.9% respectively.

The S.C.C. Hill light sub-group ranged from a gain of 7.4% in tibia length to a loss of 5.5% in girth, while the heavy sub-group ranged from a gain of

3.3% in leg length to a loss of 5.9% in girth, giving average gains of 1.9% and 0.1% respectively. The N.C.C. Hill light sub-group ranged from a gain of 4.4% in leg length to a loss of 5.7% in girth, while in the heavy sub-group the range was very similar, from a gain of 4.5% in leg length to a loss of 6.8% in girth, giving an average gain of 0.3% in the light animals and an average loss of 0.5% in the heavy.

In the S.C.C. H.P. group the light animals responded more over the treatment period than the heavy in all measurements except body length and leg length, in the former the failure of the light sub-group to increase must be considered as due to error in measuring, and in the latter there was little difference between the weight classes. In addition, in the light animals the body measurements increased more relative to the leg measurements than was the case in the heavy animals. This picture was repeated in the N.C.C. H.P. group although to a slightly lesser degree and with only one exception, the tibia length of the heavy animals having increased more than that of the light.

In the S.C.C. M.P. group there was little difference between the two sub-groups in the relative responses of most of the measurements, only leg length gaining very much more in the heavy animals than in the light, although there was a tendency for the heavy animals to gain slightly more in several other measurements. In the N.C.C. M.P. group there was virtually no difference in relative response between the two sub-groups in the three leg measurements and the two pelvis measurements but in both girth and body length the light animals gained more than the heavy.

In the S.C.C. Hill group there was practically no difference in relative response between the two sub-groups in the four body measurements but in the three leg measurements the light animals gained considerably more than the heavy. In the N.C.C. Hill group, however, there was virtually no difference in relative response in any of the measurements, with only the heavy animals losing slightly more flesh and fat cover on the two pelvis measurements.

Analysis of variance showed no significant differences in any of the measurements between the sub-group means in either weight class at the start of the treatment period. By the end of the treatment period at 49 weeks of age, covariance analysis showed in the S.C.C. breed that only in girth and pelvis length did the treatments create significant differences between all three sub-groups in both weight classes. This would also have been the case in pelvis width but for the M.P. light animals which failed to respond relatively as well as the heavy and remained non-significantly different from the Hill light. This latter situation was repeated in the light weight class in body length, cannon length and tibia length, with the M.P. and Hill sub-groups not being significantly different although both were significantly shorter in each measurement than the H.P. sub-group. However, in the heavy weight class there were no significant differences between the treatment means in tibia length and the only significant differences present in the other two measurements were between the H.P. and Hill sub-groups in body length and between the H.P. and Hill and the M.P. and Hill in cannon length. This cannon length situation in the heavy weight class was repeated by leg length but in the light weight class there were no significant treatment differences in the latter measurement.

In the N.C.C. breed at 49 weeks, as in the S.C.C. breed, the treatments had created significant differences between all three sub-groups in both weight classes in girth and pelvis length. In this breed, however, they had also done so in pelvis width, while in body length only between the M.P. and Hill light animals was there no significant difference. In tibia length in both weight classes the Hill animals were significantly shorter than those in both the respective H.P. and M.P. sub-groups which did not differ significantly. In cannon length in both weight classes the H.P. animals were significantly longer than those in the Hill sub-groups but only in the light weight class was the difference between the H.P. and M.P. sub-groups significant. Treatment effects were even more pronounced on leg length in the light weight class, all sub-groups being significantly different but in the heavy weight class there were no significant differences between the treatments in this measurement.

Born 1958. In the S.C.C. Away group, the gains which occurred in the light sub-group ranged from 9.3% in tibia length to 5.3% in girth, while the gains in the heavy sub-group were very similar, ranging from 9.8% in tibia length to 4.1% in girth. The seven measurements gave an average increase in size of 7.2% in both sub-groups. The N.C.C. Away light sub-group gains ranged from 10.3% in tibia length to 6.1% in girth, while the heavy sub-group gains ranged from 7.3% in cannon length to 5.1% in girth and leg length, giving average gains of 8.4% and 6.2% respectively.

The S.C.C. Hill light sub-group ranged from a gain of 4.4% in cannon length to no change in girth, while the heavy sub-group ranged from a gain of 4.6% in leg length to a loss of 0.5% in pelvis length, giving average gains of 2.1% and 1.8% respectively. The N.C.C. Hill light sub-group ranged from a gain of 5.0% in cannon length to a gain of 1.1% in pelvis length, while the heavy sub-group ranged from a gain of 3.3% in tibia length to a loss of 1.3% in girth, giving average gains of 2.7% and 1.3% respectively.

In the S.C.C. Away group there was no difference between the two sub-groups in the relative responses of any of the measurements over the treatment period. In the N.C.C. Away group, however, the light animals responded more than the heavy in all the measurements. In the S.C.C. Hill group there was little difference in relative response between the two sub-groups in most of the measurements with only a slightly greater increase in the two pelvis measurements and cannon length in the light animals and a slightly greater increase in leg length in the heavy animals. In the N.C.C. Hill group the light animals responded slightly more than the heavy in all measurements except body length and tibia length and in these there was very little difference.

Analysis of variance showed no significant differences in any of the measurements between the sub-group means in either weight class at the start of the treatment period. By the end of the treatment period at 49 weeks of age, covariance analysis showed in the S.C.C. breed that only in body length and the two pelvis measurements did the treatments create a significant difference in both weight classes. In girth and tibia length there was a significant difference between the treatment means in the light weight class but not in the heavy weight class, while it was the exact opposite in cannon length and there was no significant difference in leg length in either weight class.

In the N.C.C. breed at 49 weeks the treatments had created significant differences in both weight classes in all measurements except girth and body length. In girth, only in the heavy animals and in body length, only in the light animals, were the treatment means significantly different.

2. Summer after treatment, 12 - 18 months.

(a) Total groups. The actual mean live measurements recorded over the summer after treatment in each experimental year are shown in Tables 26, 26a and 26b. Total and percentage gains by each measurement from the start of the treatment period to the middle and end of the summer are shown in Tables 27, 27a and 27b, while the percentage gains are illustrated in Figs. VII, VIIa and VIIb. Adjusted means from covariance analysis and the significance of differences between them are shown in Tables 28, 28a and 28b.

Born 1956. Over the first eight weeks after treatment the H.P. groups in both breeds increased in size by a further 6.0%, being the average gain of the seven live measurements, making the S.C.C. animals 13.0% and the N.C.C. animals 13.2% larger at 57 weeks than they were prior to treatment. In both breeds pelvis width showed the greatest relative increase and girth the least. During this time the M.P. groups, S.C.C. and N.C.C. respectively, increased in size by a further 5.7% and 7.1%, making them 8.6% and 8.9% larger at 57 weeks than they were prior to treatment. Here also in both breeds pelvis width showed the greatest relative increase but tibia length showed the least. In the L.P.

Table 26

Mean live measurements over summer after treatment (mms.)

Born 1956

	S.C.C.									N.C.C.								
	49 weeks			57 weeks			80 weeks			49 weeks			57 weeks			80 weeks		
	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.
Girth	749	687	650	775	725	712	835	796	797	785	702	675	812	769	744	859	840	815
Body length	620	593	579	658	618	609	673	647	648	640	620	600	677	647	644	700	682	685
Pelvis length	196	186	181	209	198	194	216	208	206	203	198	191	217	211	205	224	220	216
Pelvis width	161	148	144	174	162	160	180	173	173	164	158	151	179	175	167	187	187	181
Cannon length	124	119	119	131	125	126	130	126	127	131	127	128	137	135	134	134	135	134
Leg length	339	332	320	359	350	347	372	362	364	355	346	350	375	371	366	390	382	387
Tibia length	185	180	174	191	185	184	194	189	189	195	191	193	203	199	198	208	204	203

Table 26a

Mean live measurements over summer after treatment (mms.)

Born 1957

	S.C.C.									N.C.C.								
	49 weeks			57 weeks			79 weeks			49 weeks			57 weeks			79 weeks		
	H.P.	M.P.	Hill	H.P.	M.P.	Hill	H.P.	M.P.	Hill	H.P.	M.P.	Hill	H.P.	M.P.	Hill	H.P.	M.P.	Hill
Girth	748	672	633	725	692	675	793	771	751	782	714	663	747	730	695	830	821	793
Body length	624	591	575	638	637	609	679	675	653	652	610	585	676	646	625	703	696	665
Pelvis length	202	193	184	206	201	193	220	214	207	211	200	188	213	209	196	228	225	215
Pelvis width	157	146	141	166	157	152	183	176	172	160	149	139	167	162	148	185	182	169
Cannon length	120	120	117	121	122	121	122	123	124	134	129	127	137	134	131	137	137	135
Leg length	341	338	337	353	348	342	353	354	353	379	374	363	384	384	370	395	393	383
Tibia length	179	178	173	181	183	179	184	187	181	199	194	186	203	201	194	207	205	199

Table 26b

Mean live measurements over summer after treatment (mms.)

Born 1958

	S.C.C.						N.C.C.					
	49 weeks		68 weeks		82 weeks		49 weeks		68 weeks		82 weeks	
	Away	Hill	Away	Hill	Away	Hill	Away	Hill	Away	Hill	Away	Hill
Girth	673	638	775	758	769	760	688	656	803	777	800	779
Body length	613	583	678	656	688	667	627	608	697	682	706	696
Pelvis length	197	183	212	208	215	212	201	190	222	217	224	219
Pelvis width	151	139	176	169	180	174	156	147	185	182	189	186
Cannon length	122	120	126	127	126	129	133	126	137	135	137	135
Leg length	343	340	352	357	361	361	370	359	383	381	391	385
Tibia length	179	171	184	185	189	189	194	184	203	198	205	201

Table 27

Actual and percentage gain in mean live measurements from start of treatment period to 57 and 80 weeks. Actual gain in mms. Percentage gain in brackets.

Born 1956

	S.C.C.						N.C.C.					
	27 - 57 weeks			27 - 80 weeks			27 - 57 weeks			27 - 80 weeks		
	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.
Girth	97(14.3)	54(8.0)	38(5.6)	157(23.1)	125(18.6)	123(18.2)	103(14.5)	58(8.2)	18(2.5)	150(21.2)	129(18.1)	89(12.3)
Body length	79(13.6)	42(7.3)	30(5.2)	94(16.2)	71(12.3)	69(11.9)	91(15.5)	44(7.3)	29(4.7)	114(19.5)	79(13.1)	70(11.4)
Pelvis length	23(12.4)	14(7.6)	9(4.9)	30(16.1)	24(13.0)	21(11.4)	26(13.6)	19(9.9)	15(7.9)	33(17.3)	28(14.6)	26(13.7)
Pelvis width	28(19.2)	16(11.0)	13(8.8)	34(23.3)	27(18.5)	26(17.7)	29(19.3)	21(13.6)	13(8.4)	37(24.7)	33(21.4)	27(17.5)
Cannon length	11(9.2)	7(5.9)	7(5.9)	10(8.3)	8(6.8)	8(6.7)	12(9.6)	9(7.1)	9(7.2)	9(7.2)	9(7.1)	9(7.2)
Leg length	38(11.8)	39(12.5)	28(8.8)	51(15.9)	51(16.4)	45(14.1)	29(8.4)	23(6.6)	26(7.6)	44(12.7)	34(9.8)	47(13.8)
Tibia length	18(10.4)	13(7.6)	9(5.1)	21(12.1)	17(9.9)	14(8.0)	21(11.5)	17(9.3)	12(6.5)	26(14.3)	22(12.1)	17(9.1)
Mean % gain	13.0	8.6	6.3	16.4	13.6	12.6	13.2	8.9	6.4	16.7	13.7	12.1

Table 27a

Actual and percentage gain in mean live measurements from start of treatment period to 57 and 79 weeks. Actual gain in mms. Percentage gain in brackets.

Born 1957

	S.C.C.						N.C.C.					
	22 - 57 weeks			22 - 79 weeks			22 - 57 weeks			22 - 79 weeks		
	H.P.	M.P.	Hill	H.P.	M.P.	Hill	H.P.	M.P.	Hill	H.P.	M.P.	Hill
Girth	49(7.2)	20(3.0)	6(0.9)	117(17.3)	99(14.7)	82(12.3)	41(5.8)	28(4.0)	-12(-1.7)	124(17.6)	119(17.0)	86(12.2)
Body length	67(11.7)	46(7.8)	27(4.6)	108(18.9)	84(14.2)	71(12.2)	73(12.1)	45(7.5)	26(4.3)	100(16.6)	95(15.8)	66(11.0)
Pelvis length	24(13.2)	16(8.6)	11(6.0)	38(20.9)	29(15.7)	25(13.7)	24(12.7)	18(9.4)	6(3.2)	39(20.6)	34(17.8)	25(13.2)
Pelvis width	26(18.6)	17(12.1)	11(7.8)	43(30.7)	36(25.7)	31(22.0)	24(16.8)	19(13.3)	6(4.2)	42(29.4)	39(27.3)	27(19.0)
Cannon length	9(8.0)	8(7.0)	8(7.1)	10(8.9)	9(7.9)	11(9.7)	13(10.5)	10(8.1)	8(6.5)	13(10.5)	13(10.5)	12(9.8)
Leg length	35(11.0)	27(8.4)	19(5.9)	35(11.0)	33(10.3)	30(9.3)	35(10.0)	32(9.1)	23(6.6)	46(13.2)	41(11.6)	36(10.4)
Tibia length	16(9.7)	14(8.3)	13(7.8)	19(11.5)	18(10.7)	15(9.0)	22(12.2)	19(10.4)	14(7.8)	26(14.4)	23(12.6)	19(10.6)
Mean % gain	11.3	7.9	5.7	17.0	14.2	12.6	11.4	8.8	4.4	17.5	16.1	12.3

Table 27b

Actual and percentage gain in mean live measurements from start of treatment period to 68 and 82 weeks. Actual gain in mms. Percentage gain in brackets.

Born 1958

	S.C.C.				N.C.C.			
	25 - 68 weeks		25 - 82 weeks		25 - 68 weeks		25 - 82 weeks	
	Away	Hill	Away	Hill	Away	Hill	Away	Hill
Girth	131(20.3)	120(18.8)	125(19.4)	122(19.1)	150(23.0)	126(19.4)	147(22.5)	128(19.7)
Body length	105(18.3)	80(13.9)	115(20.1)	91(15.8)	110(18.7)	89(15.0)	119(20.3)	103(17.4)
Pelvis length	29(15.8)	25(13.7)	32(17.5)	29(15.8)	33(17.5)	28(14.8)	35(18.5)	30(15.9)
Pelvis width	37(26.6)	31(22.5)	41(29.5)	36(26.1)	41(28.5)	37(25.5)	45(31.3)	41(28.3)
Cannon length	13(11.5)	12(10.4)	13(11.5)	14(12.2)	15(12.3)	13(10.7)	15(12.3)	13(10.7)
Leg length	27(8.3)	30(9.2)	36(11.1)	34(10.4)	34(9.7)	32(9.2)	42(12.0)	36(10.3)
Tibia length	21(12.9)	20(12.1)	26(16.0)	24(14.5)	24(13.4)	19(10.6)	26(14.5)	22(12.3)
Mean % gain	16.2	14.4	17.9	16.3	17.6	15.0	18.8	16.4

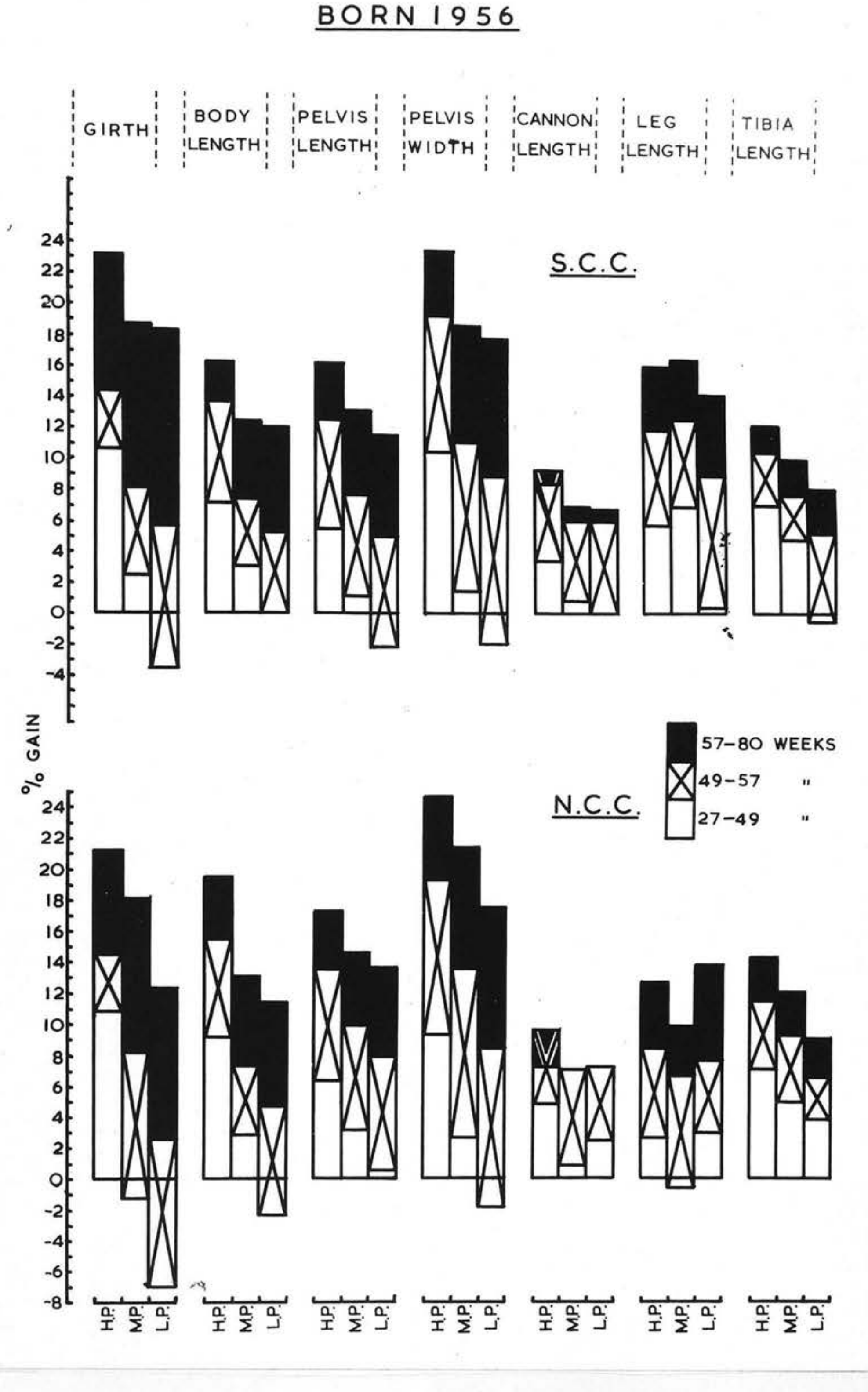

Fig. VII. Percentage gain in mean live measurements from start of treatment period to 18 months of age.

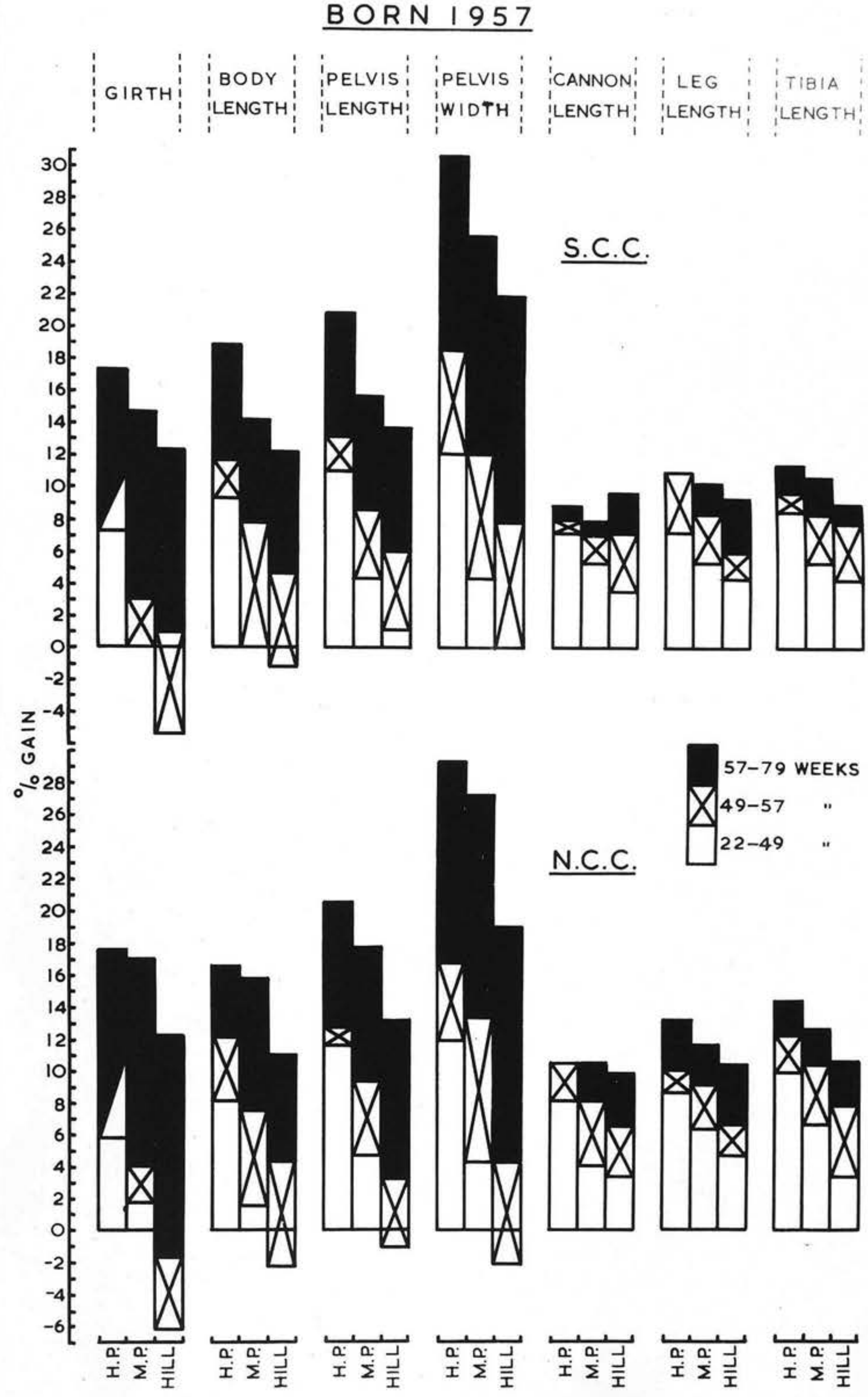

Fig. VIIa. Percentage gain in mean live measurements from start of treatment period to 18 months of age.

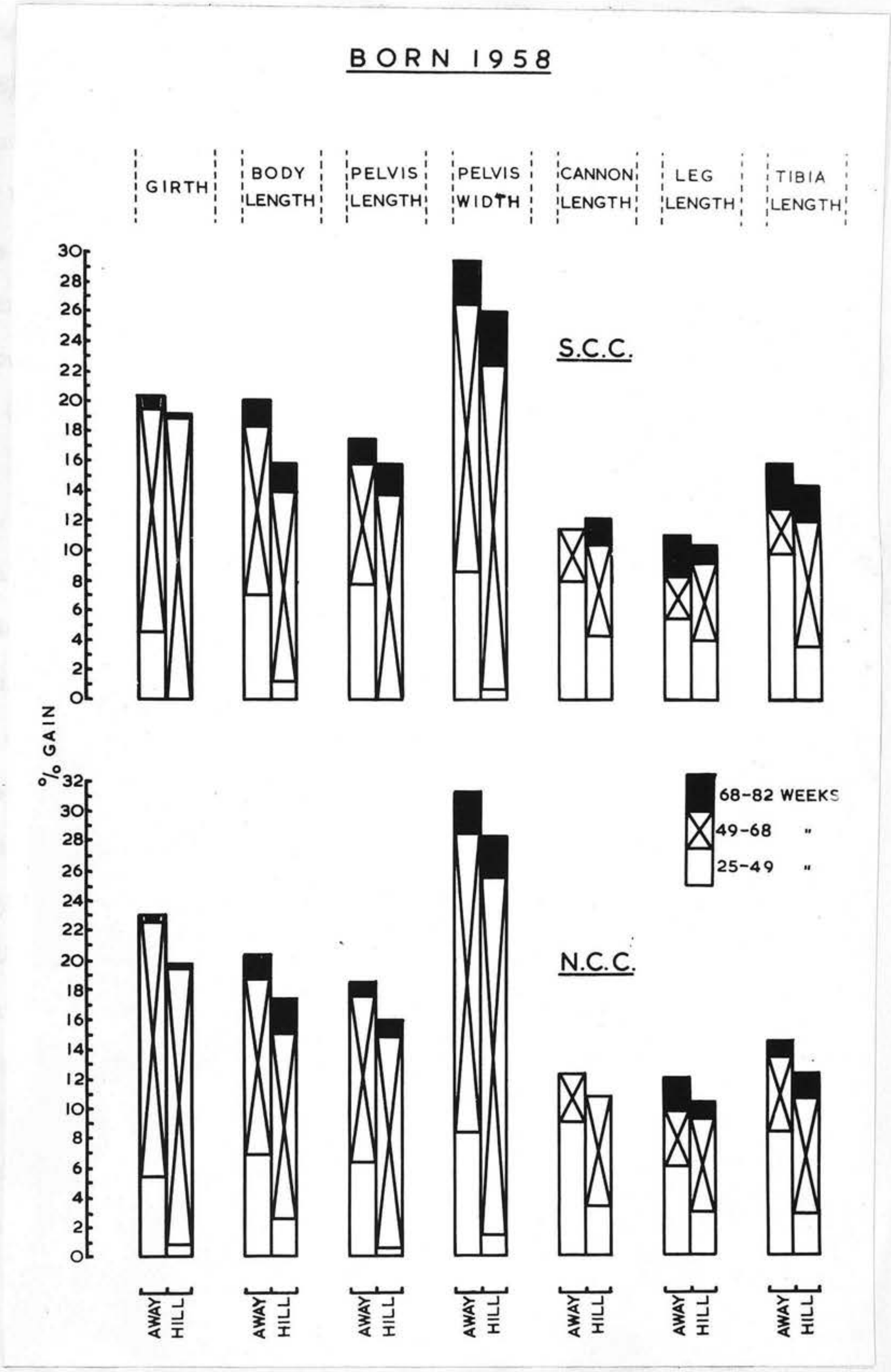

Fig. VIIb. Percentage gain in mean live measurements from start of treatment period to 18 months of age.

groups, S.C.C. and N.C.C. respectively, the increases in size during this time were 7.5% and 6.6%, making them 6.3% and 6.4% larger at 57 weeks than they were prior to treatment. Here again pelvis width showed the greatest relative increase in both breeds and tibia length the least in the N.C.C. breed but body length showed the least in the S.C.C. breed.

After this initial rapid increase in size in all treatment groups, growth was very much slower in all measurements from 57 - 80 weeks. During this time the H.P. groups, S.C.C. and N.C.C. respectively, increased in size by only a further 3.4% and 3.5%, making them 16.4% and 16.7% larger at 18 months than they were at 6 months. In both breeds girth showed the greatest relative increase and cannon length growth ceased, even appearing to lose some tissue cover although this may be due to error in measuring. The M.P. groups, S.C.C. and N.C.C. respectively, increased in size by a further 5.0% and 4.8%, making them 13.6% and 13.7% larger at 18 months than they were at 6 months. Here also girth showed the greatest relative increase in both breeds and cannon length the least, growth ceasing in the N.C.C. breed. The L.P. groups, S.C.C. and N.C.C. respectively, increased in size by a further 6.3% and 5.7%, making them 12.6% and 12.1% larger at 18 months than they were at 6 months. Here again girth showed the greatest relative increase in both breeds and cannon length the least, growth ceasing, as in the M.P. group, in the N.C.C. breed.

In the S.C.C. breed, all treatment groups in body length and the two pelvis measurements which were significantly different at 49 weeks were still so at 57 weeks but only in pelvis length did they remain so at 80 weeks, in the other two measurements the difference between the M.P. and L.P. groups had ceased to be significant. In cannon length the H.P. group was still significantly longer than both the other two groups at 57 weeks but by 80 weeks all significance had disappeared. The significant differences present at 49 weeks between the M.P. and L.P. groups in girth, the H.P. and L.P. groups in leg length and the H.P. and M.P. groups in tibia length had disappeared by 57 weeks. In girth, this

Table 28

Adjusted mean live measurements and significance of differences between them over summer after treatment.

Born 1956

		S.C.C. 57 weeks			S.C.C. 80 weeks			N.C.C. 57 weeks			N.C.C. 80 weeks		
		H.P.(10)+	M.P.(11)	L.P.(12)	H.P.(10)	M.P.(11)	L.P.(12)	H.P.(12)	M.P.(12)	L.P.(11)	H.P.(12)	M.P.(12)	L.P.(11)
Girth	H.P.	774			834			814			862		
	M.P.	***	727		**	797		***	769		NS	842	
	L.P.	***	NS	712	**	NS	797	***	*	740	***	**	811
Body length	H.P.	658			673			687			708		
	M.P.	***	622		**	650		**	648		**	683	
	L.P.	***	*	606	***	NS	646	***	NS	639	**	NS	681
Pelvis length	H.P.	207.9			214.9			217.1			224.1		
	M.P.	***	199.8		**	209.8		***	210.5		*	219.4	
	L.P.	***	**	193.6	***	*	205.5	***	**	205.0	***	NS	216.4
Pelvis width	H.P.	174.6			181.4			181.3			189.4		
	M.P.	***	162.8		**	174.2		**	173.3		NS	185.3	
	L.P.	***	*	158.3	***	NS	171.3	***	*	166.2	*	NS	179.7
Cannon length	H.P.	130.2			129.0			136.8			134.5		
	M.P.	***	126.7		NS	126.9		NS	135.2		NS	135.0	
	L.P.	***	NS	125.8	NS	NS	126.6	NS	NS	134.2	NS	NS	134.1
Leg length	H.P.	353			366			374			389		
	M.P.	NS	357		NS	369		NS	371		NS	382	
	L.P.	NS	*	346	NS	NS	363	NS	NS	369	NS	NS	391
Tibia length	H.P.	191.3			194.9			204.1			209.5		
	M.P.	NS	187.6		NS	191.2		**	199.8		*	205.3	
	L.P.	***	**	181.6	**	NS	186.9	***	*	195.6	***	*	200.7

+ Number of animals in brackets.
*** = Significant at 0.1% level of probability.
** = " " 1% " " "
* = Significant at 5% level of probability.
NS = Non-significant.

Table 28a

Adjusted mean live measurements and significance of differences between them over summer after treatment.

Born 1957

		S.C.C.						N.C.C.					
		57 weeks			79 weeks			57 weeks			79 weeks		
		H.P.(12)+	M.P.(9)	Hill(10)	H.P.(11)	M.P.(9)	Hill(10)	H.P.(13)	M.P.(13)	Hill(13)	H.P.(13)	M.P.(13)	Hill(13)
Girth	H.P.	723			790			747			830		
	M.P.	**	692		NS	772		NS	730		NS	822	
	Hill	***	NS	675	*	NS	754	***	***	694	*	*	793
Body length	H.P.	644			685			676			703		
	M.P.	NS	631		NS	669		***	645		NS	695	
	Hill	**	*	607	**	NS	652	***	*	626	***	**	666
Pelvis length	H.P.	206.4			220.5			214.3			228.6		
	M.P.	**	200.4		**	213.0		***	207.8		*	223.8	
	Hill	***	***	192.3	***	*	207.4	***	***	196.7	***	***	215.1
Pelvis width	H.P.	165.7			182.7			167.6	—		184.9		
	M.P.	***	157.2		*	176.7		**	161.2		NS	181.1	
	Hill	***	**	151.2	**	NS	171.4	***	***	148.8	***	***	169.8
Cannon length	H.P.	121.8			123.2			136.3			137.3		
	M.P.	NS	122.0		NS	123.4		**	133.9		NS	136.4	
	Hill	NS	NS	120.6	NS	NS	123.4	***	**	131.6	NS	NS	135.0
Leg length	H.P.	355			355			385			395		
	M.P.	NS	349		NS	355		NS	382		NS	391	
	Hill	***	*	340	NS	NS	350	***	**	372	*	NS	384
Tibia length	H.P.	181.4			185.2			203.3			206.5		
	M.P.	NS	182.0		NS	186.0		NS	199.5		NS	203.6	
	Hill	NS	NS	178.5	NS	NS	181.5	**	NS	195.0	**	NS	200.1

+ Number of animals in brackets.
*** = Significant at 0.1% level of probability.
** = " " 1% " " "
* = Significant at 5% level of probability.
NS = Non-significant.

Table 28b

Adjusted mean live measurements and significance of differences between them over summer after treatment.

Born 1958

	S.C.C.				N.C.C.			
	68 weeks		82 weeks		68 weeks		82 weeks	
	Away(13)+	Hill(13)	Away(13)	Hill(13)	Away(15)	Hill(15)	Away(15)	Hill(15)
Girth (Away (Hill	774 NS	759	767 NS	761	803 **	777	799 *	780
Body length (Away (Hill	669 **	655	689 **	666	699 *	681	707 NS	695
Pelvis length (Away (Hill	211.6 NS	208.2	214.9 NS	211.4	222.2 **	216.8	223.7 *	219.0
Pelvis width (Away (Hill	176.1 **	169.5	180.0 *	174.8	185.5 *	181.3	189.2 NS	186.0
Cannon length (Away (Hill	126.8 NS	126.2	126.8 NS	127.3	136.8 NS	134.9	137.0 NS	135.2
Leg length (Away (Hill	353 NS	357	362 NS	360	383 NS	381	391 *	385
Tibia length (Away (Hill	185.1 NS	184.5	189.6 NS	187.7	202.8 *	198.3	204.9 NS	201.3

+ Number of animals in brackets.
** = Significant at 1% level of probability.
* = Significant at 5% level of probability.
NS = Non-significant.

remained the situation at 80 weeks but in the other two measurements the differences between the M.P. and L.P. groups had also ceased to be significant. In the S.C.C. breed at 18 months of age then, only in the four body measurements and tibia length were the differences between the H.P. and L.P. groups significant, while only in the four body measurements were they significant between the H.P. and M.P. groups and only in pelvis width were they significant between the M.P. and L.P. groups.

In the N.C.C. breed, those treatment groups in girth and the two pelvis measurements which were significantly different at 49 weeks were still so at 57 weeks but by 80 weeks the differences between the H.P. and M.P. groups in girth, the M.P. and L.P. groups in pelvis length and the H.P. and M.P. and the M.P. and L.P. groups in pelvis width had ceased to be significant. The difference between the M.P. and L.P. groups in body length which was significant at 49 weeks was no longer so at 57 weeks and this remained the situation in this measurement at 80 weeks. In tibia length the difference between the M.P. and L.P. groups which was not significant at 49 weeks had become so at 57 weeks and remained so at 80 weeks. None of the differences between the groups in cannon length and leg length were significant at 57 or 80 weeks. In the N.C.C. breed at 18 months of age then, only in the four body measurements and tibia length were the differences between the H.P. and L.P. groups significant, while only in body length, pelvis length and tibia length were they significant between the H.P. and M.P. groups and only in girth and tibia length were they significant between the M.P. and L.P. groups.

Born 1957. Over the first eight weeks after treatment the H.P. groups, S.C.C. and N.C.C. respectively, increased in size by a further 1.9% and 1.5%, making them 11.3% and 11.4% larger at 57 weeks than they were prior to treatment. In both breeds pelvis width showed the greatest relative increase and girth decreased. During this time the M.P. groups, S.C.C. and N.C.C. respectively, increased in size by a further 4.4% and 4.7%, making them 7.9% and 8.8% larger at 57 weeks than they were prior to treatment. Here also in both breeds pelvis width showed the greatest relative increase but in the S.C.C. breed cannon length showed the least while girth showed the least in the N.C.C. breed. In the Hill groups, S.C.C. and N.C.C. respectively, the increases in size during this time were 4.8% and 4.5%, making them 5.7% and 4.4% larger at 57 weeks than they were prior to treatment. Here again pelvis width showed the greatest relative increase in both breeds while leg length showed the least.

After this limited increase in size in all the measurements, particularly in the H.P. groups, growth continued at approximately the same rate from 57 - 79 weeks in the four body measurements but slowed considerably in the three leg measurements. During this time the H.P. groups, S.C.C. and N.C.C respectively, increased in size by a further 5.7% and 6.1%, making them 17.0% and 17.5% larger at 18 months than they were at 5 months. In both breeds pelvis width continued to show the greatest relative increase while growth ceased in the S.C.C. leg length and N.C.C. cannon length. The M.P. groups, S.C.C. and N.C.C. respectively, increased in size by a further 6.3% and 7.3%, making them 14.2% and 16.1% larger at 18 months than they were at 5 months. Here also pelvis width showed the greatest relative increase in both breeds and cannon length the least, although in the N.C.C. breed there was little difference in relative gain between any of the leg measurements. The Hill groups, S.C.C. and N.C.C. respectively, increased in size by a further 6.9% and 7.9%, making them 12.6% and 12.3% larger at 18 months than they were at 5 months. Here again pelvis width showed the greatest relative increase in both breeds while tibia length showed the least.

In the S.C.C. breed, all treatment groups in the two pelvis measurements which were significantly different at 49 weeks were still so at 57 weeks but only in pelvis length did they remain so at 79 weeks, in pelvis width the difference between the M.P. and Hill groups had ceased to be significant. In girth the difference between the M.P. and Hill groups ceased to be significant at 57 weeks and that between the H.P. and M.P. groups ceased to be so at 79 weeks. In body length the M.P. group increased to such an extent between 49 and 57 weeks that by the latter time it had ceased to be significantly different from the H.P. group and had become significantly greater than the Hill group, though by 79 weeks this significance had once again disappeared. The significant differences present between the groups at 49 weeks in cannon length and tibia length had all disappeared by 57 weeks and this remained the situation at 79 weeks. The very limited gain in leg length between 49 and 57 weeks in the Hill group resulted in it becoming significantly shorter than the other two at 57 weeks but by 79 weeks the difference was once more non-significant. In the S.C.C. breed at 18 months of age then, only in the four body measurements were the differences between the H.P. and Hill groups significant while only in the two pelvis measurements were they significant between the H.P. and M.P. groups and only in pelvis length were they significant between the M.P. and Hill groups.

In the N.C.C. breed, all treatment groups in body length, the two pelvis measurements and cannon length which were significantly different at 49 weeks were still so at 57 weeks but only in pelvis length did they remain so at 79 weeks, in body length and pelvis width the differences between the H.P. and M.P. groups had ceased to be significant, while in cannon length none of the differences were significant. The significant differences present at 49 weeks between the H.P. and M.P. groups in girth and leg length and between the M.P. and Hill groups in tibia length had disappeared by 57 weeks. In girth and tibia length this remained the situation at 79 weeks but in leg length the difference between the M.P. and Hill groups had also ceased to be significant. In the N.C.C. breed at 18 months of age then, only in cannon length was the difference between the H.P. and Hill groups not significant while the only significant difference between the H.P. and M.P. groups was in pelvis length and only in the four body measurements were the differences between the M.P. and Hill groups significant.

Born 1958. In this year the mid-summer recording was not taken until 68 weeks, 11 weeks later than in the previous two years. During this time, from

April to August, the Away groups, S.C.C. and N.C.C. respectively, increased in size by a further 8.9% and 10.4%, making them 16.2% and 17.6% larger at 68 weeks than they were prior to treatment. In both breeds pelvis width showed the greatest relative increase while leg length showed the least in the S.C.C. breed and cannon length the least in the N.C.C. breed. During this time the Hill groups, S.C.C. and N.C.C. respectively, increased in size by a further 12.4% and 13.0%, making them 14.4% and 15.0% larger at 68 weeks than they were prior to treatment. Here also pelvis width showed the greatest relative increase in both breeds, while leg length showed the least.

After this considerable increase in size, particularly in the body measurements in both treatment groups, growth was very limited in all measurements during the last 14 weeks of the summer from 68 - 82 weeks. During this time the Away groups, S.C.C. and N.C.C. respectively, increased in size by only a further 1.7% and 1.2%, making them 17.9% and 18.8% larger at 18 months than they were at 6 months. In the S.C.C. breed tibia length and pelvis width showed the greatest relative increase, being very similar, while in the N.C.C. breed pelvis width continued to show the greatest relative increase. In both breeds girth decreased slightly. During this time the Hill groups, S.C.C. and N.C.C. respectively, increased in size by only a further 1.9% and 0.6%, making them 16.3% and 16.4% larger at 18 months than they were at 6 months. Here again pelvis width showed the greatest relative increase in both breeds and girth the least in the S.C.C. breed while growth ceased in the N.C.C. cannon length.

In the S.C.C. breed the only measurements where significant differences were still present at 68 weeks between the treatments were body length and pelvis width. This remained the situation at 18 months. In the N.C.C. breed significant differences were still present between the treatments at 68 weeks in all measurements except cannon length and leg length. At 18 months, however, only in girth and pelvis length were the treatment means still significantly different while the difference in leg length had also become significant.

(b) Heavy and light hoggs prior to treatment. The actual mean live measurements recorded over the summer after treatment in each experimental year are shown in Tables 29, 29a and 29b. Total and percentage gains by each measurement in both weight classes from the start of the treatment period to the middle and end of the summer are shown in Tables 30, 30a and 30b, while the percentage gains are illustrated in Figs. VIII, VIIIa and VIIIb. Adjusted means from covariance analysis and the significance of differences between them in each weight class are shown in Tables 31, 31a and 31b.

Born 1956. Over the first eight weeks after treatment the H.P. heavy sub-groups, S.C.C. and N.C.C. respectively, increased in size by a further 5.2% and 5.4%, compared with the H.P. light sub-groups, which increased by 7.1% and 6.1%, making the former 11.3% and 12.2% and the latter 15.5% and 13.3% larger at 57 weeks than they were prior to treatment. During this time both M.P. heavy sub-groups increased in size by a further 5.9% compared with the M.P. light sub-groups, S.C.C. and N.C.C. respectively, which increased by 6.4% and 7.7%, making the former 8.9% and 7.1% and the latter 9.5% and 10.1% larger at 57 weeks than they were prior to treatment. In the L.P. heavy sub-groups, S.C.C. and N.C.C. respectively, the increases in size during this time were 6.7% and 7.6%, compared with the L.P. light sub-groups, which increased by 8.3% and 5.6%, making the former 5.2% and 7.0% and the latter 7.9% and 5.8% larger at 57 weeks than they were prior to treatment.

Generally, between 49 and 57 weeks, in the heavy weight class in both breeds the L.P. animals exhibited greater relative gains than the H.P. and M.P. animals, which differed only slightly, the H.P. animals showing the least relative gain. In the light weight class the picture was slightly different, with the M.P. animals showing the least relative gain in the S.C.C. breed and the L.P. animals the least in the N.C.C. breed. These relative differences in growth as described by the measurements were closely related to the live weight changes discussed in the previous sections. With the exception of the N.C.C. L.P.

Table 29

Mean live measurements over summer after treatment of heavy and light hoggs prior to treatment (mms.)

Born 1956

		S.C.C.									N.C.C.								
		49 weeks			57 weeks			80 weeks			49 weeks			57 weeks			80 weeks		
		H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.
Girth	(Heavy	757	708	653	772	744	714	836	801	796	813	722	688	834	775	761	890	837	834
	(Light	739	669	647	778	715	709	834	793	801	767	689	666	796	762	730	837	842	800
Body length	(Heavy	629	603	581	669	630	604	683	653	648	655	646	605	693	672	659	709	707	706
	(Light	611	585	575	648	611	618	664	644	649	630	604	596	665	633	632	694	665	668
Pelvis length	(Heavy	200	192	183	210	204	195	219	213	206	205	204	193	219	215	209	226	224	222
	(Light	193	182	179	207	195	193	212	206	206	201	195	190	215	208	201	223	217	211
Pelvis width	(Heavy	163	153	146	176	167	161	184	177	173	169	160	156	183	173	175	192	186	190
	(Light	158	144	140	172	159	159	177	171	173	161	157	147	176	175	161	183	187	174
Cannon length	(Heavy	128	122	121	135	129	127	132	128	128	134	130	129	139	138	135	137	139	136
	(Light	120	117	117	128	124	124	129	124	125	129	125	128	135	134	133	132	133	133
Leg length	(Heavy	348	336	321	364	359	348	376	368	366	360	359	356	380	382	375	394	396	394
	(Light	329	328	318	355	345	345	368	359	361	353	338	346	371	366	359	386	373	382
Tibia length	(Heavy	189	186	177	195	191	185	198	193	190	201	196	194	206	203	201	211	211	206
	(Light	180	176	171	187	182	181	191	187	188	192	188	193	201	195	196	206	200	201

Table 29a

Mean live measurements over summer after treatment of heavy and light hoggs prior to treatment (mms.)

Born 1957

		S.C.C.									N.C.C.								
		49 weeks			57 weeks			79 weeks			49 weeks			57 weeks			79 weeks		
		H.P.	M.P.	Hill	H.P.	M.P.	Hill	H.P.	M.P.	Hill	H.P.	M.P.	Hill	H.P.	M.P.	Hill	H.P.	M.P.	Hill
Girth	(Heavy	735	688	649	728	703	695	791	779	773	776	721	672	739	743	703	834	826	796
	(Light	769	660	605	721	683	642	795	765	719	786	705	656	753	709	688	827	814	791
Body length	(Heavy	631	607	584	639	658	631	689	693	671	661	616	589	685	649	623	718	696	652
	(Light	549	580	560	636	620	573	661	661	628	646	603	583	669	641	626	691	695	676
Pelvis length	(Heavy	205	199	187	208	208	197	222	218	213	213	202	190	216	211	199	231	226	218
	(Light	198	189	178	202	196	186	217	210	198	210	197	186	211	206	195	225	224	213
Pelvis width	(Heavy	159	151	143	168	162	154	184	183	175	162	150	142	169	163	151	188	182	172
	(Light	155	142	139	163	153	148	182	170	166	159	148	136	166	160	146	182	181	166
Cannon length	(Heavy	120	124	117	122	126	122	123	128	125	135	130	129	138	134	133	140	137	135
	(Light	119	117	118	120	119	119	122	120	123	134	129	125	135	134	130	136	137	134
Leg length	(Heavy	345	350	341	355	360	348	354	365	358	385	378	368	392	387	373	403	397	390
	(Light	335	330	331	349	339	332	350	346	346	375	369	359	378	379	368	387	387	377
Tibia length	(Heavy	179	185	173	181	190	181	185	194	184	205	199	188	208	204	195	212	208	201
	(Light	180	174	174	180	178	174	183	182	178	194	188	184	200	196	193	202	199	197

Table 29b

Mean live measurements over summer after treatment of heavy and light hoggs prior to treatment (mms.).

Born 1958

		S.C.C.						N.C.C.					
		49 weeks		68 weeks		82 weeks		49 weeks		68 weeks		82 weeks	
		Away	Hill	Away	Hill	Away	Hill	Away	Hill	Away	Hill	Away	Hill
Girth	(Heavy	682	656	781	768	778	773	706	669	813	789	808	793
	(Light	656	618	765	748	755	745	662	647	788	768	788	769
Body length	(Heavy	616	590	678	661	686	674	631	619	697	684	703	698
	(Light	607	574	677	650	691	659	623	601	698	681	711	694
Pelvis length	(Heavy	199	186	213	210	216	214	203	194	223	219	225	220
	(Light	193	180	210	207	213	209	199	188	221	216	222	219
Pelvis width	(Heavy	154	141	179	171	183	176	159	150	187	182	190	186
	(Light	145	136	173	167	176	172	152	145	182	181	187	187
Cannon length	(Heavy	122	122	126	129	126	131	133	128	137	136	138	136
	(Light	121	118	125	125	125	126	131	125	137	134	137	134
Leg length	(Heavy	344	343	351	358	364	359	371	366	386	387	390	390
	(Light	341	336	353	357	357	363	368	354	380	377	393	382
Tibia length	(Heavy	179	174	184	188	190	190	195	190	204	203	206	205
	(Light	177	168	185	182	188	187	192	180	201	195	204	199

Table 30

Actual and percentage gain in mean live measurements of heavy and light hoggs prior to treatment from start of treatment period to 57 and 80 weeks. Actual gain in mms. Percentage gain in brackets.

Born 1956

		S.C.C.						N.C.C.					
		27 - 57 weeks			27 - 80 weeks			27 - 57 weeks			27 - 80 weeks		
		H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.
Girth	(H.	75(10.8)	47(6.7)	22(3.2)	139(19.9)	104(14.9)	104(15.0)	97(13.2)	44(6.0)	19(2.6)	153(20.8)	106(14.5)	92(12.4)
	(L.	121(18.4)	65(10.0)	61(9.4)	177(26.9)	143(22.0)	153(23.6)	105(15.2)	64(9.2)	16(2.2)	146(21.1)	144(20.6)	86(12.0)
Body	(H.	76(12.8)	42(7.1)	23(4.0)	90(15.2)	65(11.1)	67(11.5)	82(13.4)	47(7.5)	27(4.3)	98(16.0)	82(13.1)	74(11.7)
length	(L.	85(15.1)	45(8.0)	42(7.3)	101(17.9)	78(13.8)	73(12.7)	95(16.7)	44(7.5)	29(4.8)	124(21.8)	76(12.9)	65(10.8)
Pelvis	(H.	18(9.4)	16(8.5)	9(4.8)	27(14.1)	25(13.3)	20(10.8)	24(12.3)	16(8.0)	17(8.9)	31(15.9)	25(12.6)	30(15.6)
length	(L.	28(15.6)	15(8.3)	9(4.9)	33(18.4)	26(14.4)	22(12.0)	25(13.2)	21(11.2)	13(6.9)	33(17.4)	30(16.0)	23(12.2)
Pelvis	(H.	25(16.6)	17(11.3)	10(6.6)	33(21.9)	27(18.0)	22(14.6)	28(18.1)	13(8.1)	16(10.1)	37(23.9)	26(16.3)	31(19.5)
width	(L.	33(23.7)	17(12.0)	17(12.0)	38(27.3)	29(20.4)	31(21.8)	29(19.7)	25(16.7)	11(7.3)	36(24.5)	37(24.7)	24(16.0)
Cannon	(H.	10(8.0)	9(7.5)	6(5.0)	7(5.6)	8(6.7)	7(5.8)	10(7.8)	8(6.2)	9(7.1)	8(6.2)	9(6.9)	10(7.9)
length	(L.	13(11.3)	8(6.9)	8(6.9)	14(12.2)	8(6.9)	9(7.8)	12(9.8)	11(8.9)	8(6.4)	9(7.3)	10(8.1)	8(6.4)
Leg	(H.	37(11.3)	42(13.2)	27(8.4)	49(15.0)	51(16.1)	45(14.0)	33(9.5)	23(6.4)	29(8.4)	47(13.5)	37(10.3)	48(13.9)
length	(L.	41(13.1)	38(12.4)	29(9.2)	54(17.2)	52(16.9)	45(14.2)	26(7.5)	25(7.3)	24(7.2)	41(11.9)	32(9.4)	47(14.0)
Tibia	(H.	18(10.2)	14(7.9)	8(4.5)	21(11.9)	16(9.0)	13(7.3)	20(10.8)	14(7.4)	14(7.5)	25(13.4)	22(11.6)	19(10.2)
length	(L.	19(11.3)	15(9.0)	10(5.8)	23(13.7)	20(12.0)	17(9.9)	20(11.0)	17(9.6)	11(5.9)	25(13.8)	22(12.4)	16(8.6)
Mean	(H.	11.3	8.9	5.2	14.8	12.7	11.3	12.2	7.1	7.0	15.7	12.2	13.0
% gain	(L.	15.5	9.5	7.9	19.1	15.2	14.6	13.3	10.1	5.8	16.8	14.9	11.4

H. = Heavy
L. = Light

Table 30a

Actual and percentage gain in mean live measurements of heavy and light hoggs prior to treatment from start of treatment period to 57 and 79 weeks. Actual gain in mms. Percentage gain in brackets.

Born 1957

		S.C.C.						N.C.C.					
		22 - 57 weeks			22 - 79 weeks			22 - 57 weeks			22 - 79 weeks		
		H.P.	M.P.	Hill	H.P.	M.P.	Hill	H.P.	M.P.	Hill	H.P.	M.P.	Hill
Girth	H.	42(6.1)	15(2.2)	5(0.7)	105(15.3)	91(13.2)	83(12.0)	21(2.9)	27(3.8)	-18(-2.5)	116(16.2)	110(15.4)	75(10.4)
	L.	61(9.2)	23(3.5)	2(0.3)	135(20.5)	105(15.9)	79(12.3)	56(8.0)	26(3.8)	- 8(-1.1)	130(18.7)	131(19.2)	95(13.6)
Body length	H.	55(9.4)	40(6.5)	35(5.9)	105(18.0)	75(12.1)	75(12.6)	68(11.0)	36(5.9)	21(3.5)	101(16.4)	83(13.5)	50(8.3)
	L.	87(15.8)	49(8.6)	12(2.1)	112(20.4)	90(15.8)	67(11.9)	76(12.8)	57(9.8)	30(5.0)	98(16.5)	111(19.0)	80(13.4)
Pelvis length	H.	21(11.2)	19(10.1)	11(5.9)	35(18.7)	29(15.3)	27(14.5)	23(11.9)	18(9.3)	6(3.1)	38(19.7)	33(17.1)	25(13.0)
	L.	28(16.1)	14(7.7)	9(5.1)	43(24.7)	28(15.4)	21(11.9)	25(13.4)	18(9.6)	8(4.3)	39(21.0)	36(19.1)	26(13.9)
Pelvis width	H.	23(15.9)	18(12.5)	11(7.7)	39(26.9)	39(27.1)	32(22.4)	21(14.2)	18(12.4)	4(2.7)	40(27.0)	27(25.5)	25(17.0)
	L.	29(21.6)	16(11.7)	9(6.5)	48(35.8)	33(24.1)	27(19.4)	27(19.4)	19(13.5)	8(5.8)	43(30.9)	40(28.4)	28(20.3)
Cannon length	H.	8(7.0)	9(7.7)	7(6.1)	9(7.9)	11(9.4)	10(8.7)	12(9.5)	10(8.1)	8(6.4)	14(11.1)	13(10.5)	10(8.0)
	L.	11(10.1)	8(7.2)	7(6.3)	13(11.9)	9(8.1)	11(9.8)	12(9.8)	10(8.1)	9(7.4)	13(10.6)	13(10.5)	13(10.7)
Leg length	H.	34(10.6)	34(10.4)	18(5.5)	33(10.3)	39(12.0)	28(8.5)	35(9.8)	31(8.7)	21(6.0)	46(12.9)	41(11.5)	38(10.8)
	L.	35(11.1)	21(6.6)	19(6.1)	36(11.5)	28(8.8)	33(10.5)	35(10.2)	31(8.9)	24(7.0)	44(12.8)	39(11.2)	33(9.6)
Tibia length	H.	15(9.0)	15(8.6)	13(7.7)	19(11.4)	19(10.9)	16(9.5)	23(12.4)	18(9.7)	12(6.6)	27(14.6)	22(11.8)	18(9.8)
	L.	17(10.4)	13(7.9)	12(7.4)	20(12.3)	17(10.3)	16(9.9)	21(11.7)	19(10.7)	16(9.0)	23(12.8)	22(12.4)	20(11.3)
Mean % gain	H.	9.9	8.3	5.6	15.5	14.3	12.6	10.2	8.3	3.7	16.8	15.0	11.0
	L.	13.5	7.6	4.8	19.6	14.1	12.2	12.2	9.2	5.3	17.6	17.1	13.3

H. = Heavy
L. = Light

Table 30b

Actual and percentage gain in mean live measurements of heavy and light hoggs prior to treatment from start of treatment period to 68 and 82 weeks. Actual gain in mms. Percentage gain in brackets.

Born 1958

		S.C.C.				N.C.C.			
		25 - 68 weeks		25 - 82 weeks		25 - 68 weeks		25 - 82 weeks	
		Away	Hill	Away	Hill	Away	Hill	Away	Hill
Girth	H.	126(19.2)	112(17.1)	123(18.8)	117(17.8)	141(21.0)	111(16.4)	136(20.2)	115(17.0)
	L.	142(22.8)	130(21.0)	132(21.2)	127(20.6)	164(26.3)	134(21.1)	164(26.3)	135(21.3)
Body length	H.	102(17.7)	79(13.6)	110(19.1)	92(15.8)	104(17.5)	84(14.0)	110(18.5)	98(16.3)
	L.	110(19.4)	82(14.4)	124(21.9)	91(16.0)	119(20.6)	93(15.8)	132(22.8)	106(18.0)
Pelvis length	H.	28(15.1)	23(12.3)	31(16.8)	27(14.4)	31(16.1)	24(12.3)	33(17.2)	25(12.8)
	L.	31(17.3)	28(15.6)	34(19.0)	30(16.8)	37(20.1)	30(16.1)	38(20.7)	33(17.7)
Pelvis width	H.	37(26.1)	30(21.3)	41(28.9)	35(24.8)	38(25.5)	32(21.3)	41(27.5)	36(24.0)
	L.	39(29.1)	33(24.6)	42(31.3)	38(28.4)	44(31.9)	39(27.5)	49(35.5)	45(31.7)
Cannon length	H.	13(11.5)	11(9.3)	13(11.5)	13(11.0)	13(10.5)	11(8.8)	14(11.3)	11(8.8)
	L.	12(10.6)	12(10.6)	12(10.6)	13(11.5)	17(14.2)	15(12.6)	17(14.2)	15(12.6)
Leg length	H.	24(7.3)	30(9.1)	37(11.3)	31(9.5)	33(9.3)	28(7.8)	37(10.5)	31(8.6)
	L.	31(9.6)	31(9.5)	35(10.9)	37(11.3)	37(10.8)	35(10.2)	50(14.6)	40(11.7)
Tibia length	H.	21(12.9)	20(11.9)	27(16.6)	22(13.1)	22(12.1)	19(10.3)	24(13.2)	21(11.4)
	L.	23(14.2)	20(12.3)	26(16.0)	25(15.4)	27(15.5)	20(11.4)	30(17.2)	24(13.7)
Mean % gain	H.	15.7	13.5	17.6	15.2	16.0	13.0	16.9	14.1
	L.	17.6	15.4	18.7	17.1	19.9	16.4	21.6	18.1

H. = Heavy
L. = Light

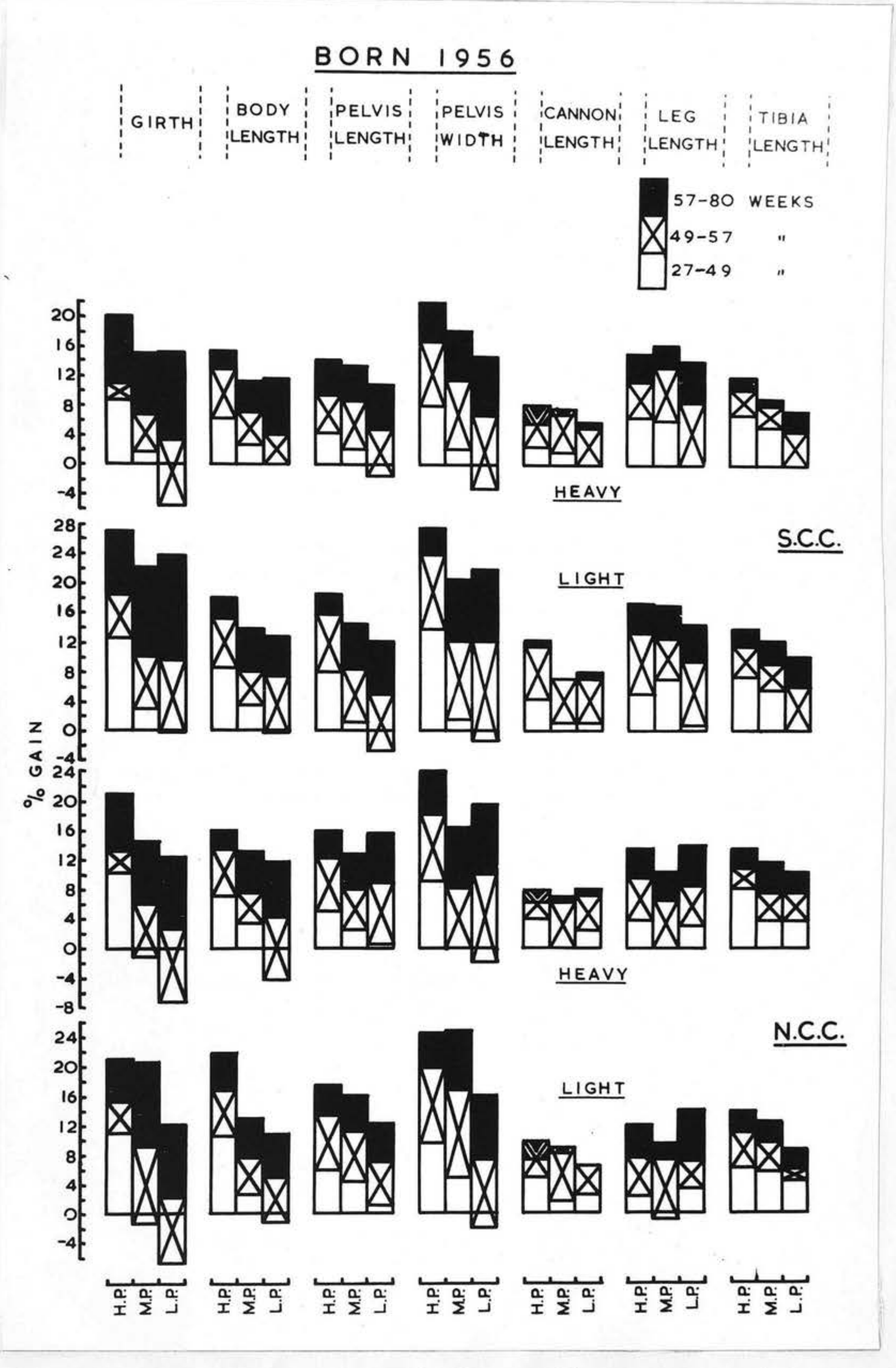

Fig. VIII. Percentage gain in mean live measurements from start of treatment period to 18 months of age of heavy and light hoggs prior to treatment.

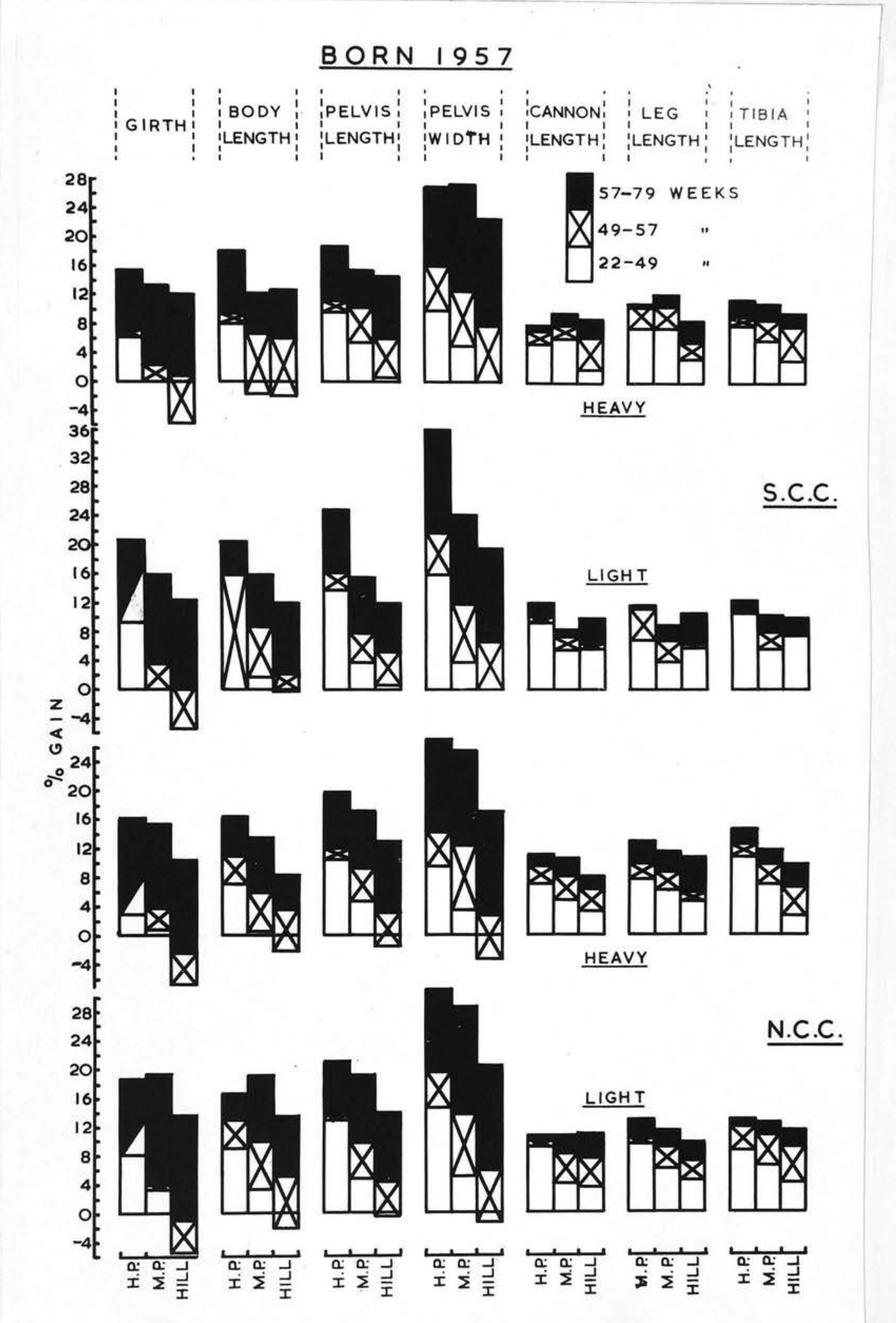

Fig. VIIIa. Percentage gain in mean live measurements from start of treatment period to 18 months of age of heavy and light hoggs prior to treatment.

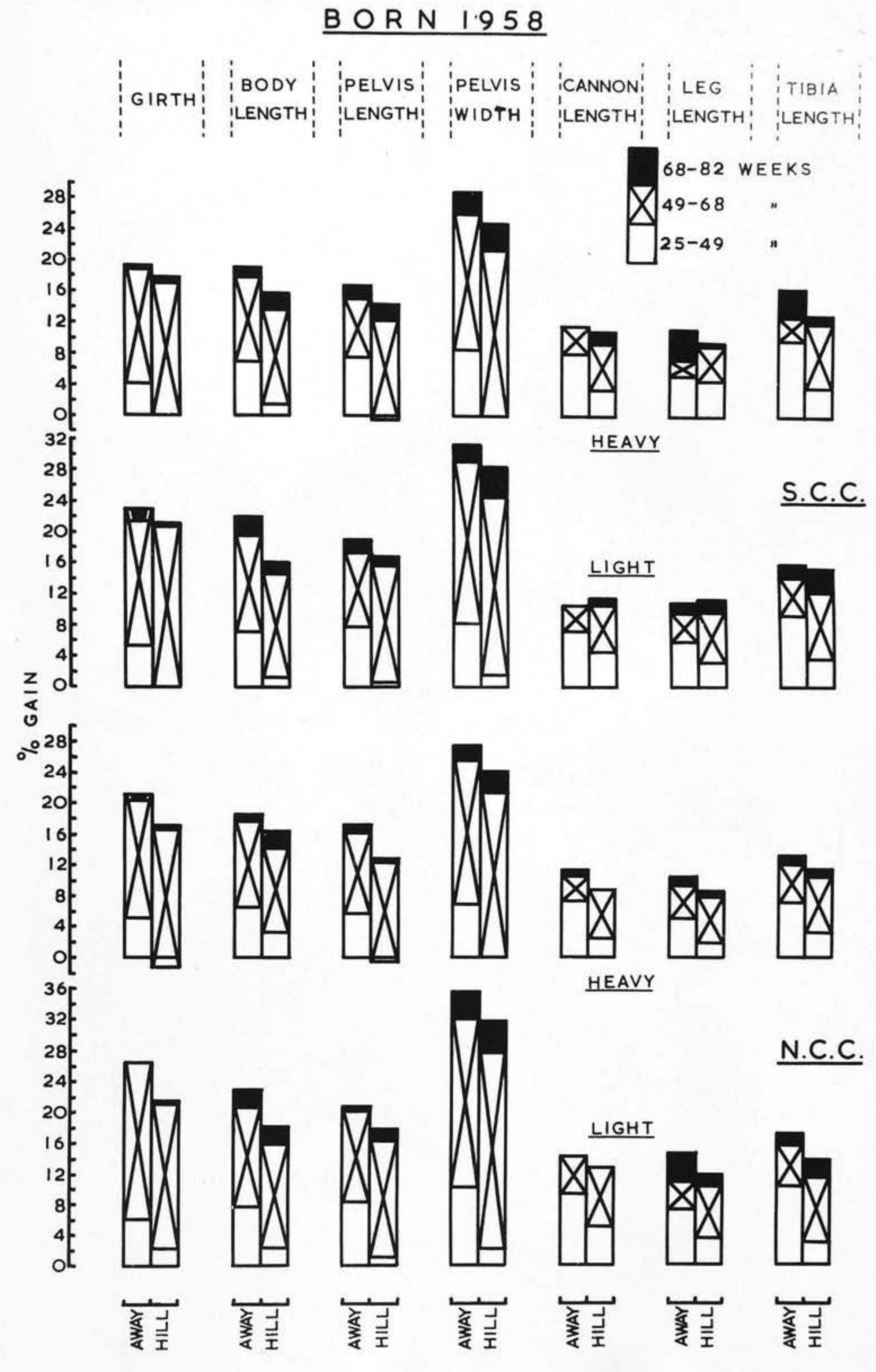

Fig. VIIIb. Percentage gain in mean live measurements from start of treatment period to 18 months of age of heavy and light hoggs prior to treatment.

group, in general, the light animals showed greater relative gains than the heavy in all treatment groups in both breeds during this time. In none of the measurements were there any striking differences in relative response between the two weight classes, the average trends applying fairly uniformly to the individual measurements.

Over the rest of the summer, from 57 - 80 weeks, both H.P. heavy sub-groups increased in size by a further 3.5%, compared with the H.P. light sub-groups, S.C.C. and N.C.C. respectively, which increased by 3.6% and 3.5%, making the former 14.8% and 15.7% and the latter 19.1% and 16.8% larger at 18 months than they were at 6 months. During this time the M.P. heavy sub-groups, S.C.C. and N.C.C. respectively, increased in size by a further 3.8% and 5.1%, compared with the M.P. light sub-groups, which increased by 5.7% and 4.8%, making the former 12.7% and 12.2% and the latter 15.2% and 14.9% larger at 18 months than they were at 6 months. In the L.P. heavy sub-groups, S.C.C. and N.C.C. respectively, the increases in size during this time were 6.1% and 6.0%, compared with the L.P. light sub-groups, which increased by 6.7% and 5.6%, making the former 11.3% and 13.0% and the latter 14.6% and 11.4% larger at 18 months than they were at 6 months.

Generally, between 57 and 80 weeks, in the heavy weight class in both breeds the L.P. animals continued to show greater relative gains than the H.P. and M.P. animals, with the H.P. animals still showing the least. In the light weight class the picture was now similar. With the exception of the S.C.C. M.P. group, in general, both weight classes showed approximately the same relative gains in all treatment groups in both breeds during this time. The S.C.C. M.P. light animals which were relatively retarded at 57 weeks gained relatively more than the corresponding heavy animals.

In the S.C.C. breed at 57 weeks the differences between the H.P. and L.P. sub-groups were still significant in all measurements except leg length in the heavy weight class and in all measurements except leg length and tibia length

Table 31

Heavy and light hoggs prior to treatment. Adjusted mean live measurements and significance of differences between them over summer after treatment, 12 - 18 months.

Born 1956

S.C.C.

		57 weeks						80 weeks					
		Heavy			Light			Heavy			Light		
		H.P.(5)+	M.P.(4)	L.P.(8)	H.P.(5)	M.P.(7)	L.P.(4)	H.P.(5)	M.P.(4)	L.P.(8)	H.P.(5)	M.P.(7)	L.P.(4)
Girth	H.P.	772			775			836			830		
	M.P.	NS	745		**	716		*	800		NS	794	
	L.P.	**	*	713	**	NS	710	*	NS	797	NS	NS	803
Body length	H.P.	664			652			678			665		
	M.P.	*	628		**	615		NS	651		NS	645	
	L.P.	**	NS	607	**	NS	607	NS	NS	651	NS	NS	647
Pelvis length	H.P.	207.7			208.4			216.3			213.5		
	M.P.	NS	203.9		***	196.5		NS	212.9		*	206.9	
	L.P.	**	*	196.6	***	*	188.8	**	*	208.0	*	NS	202.7
Pelvis width	H.P.	175.4			175.3			183.6			180.4		
	M.P.	**	167.2		***	158.4		NS	177.8		**	170.1	
	L.P.	***	*	160.4	***	NS	155.8	**	NS	173.0	**	NS	169.8
Cannon length	H.P.	132.4			127.8			128.3			129.1		
	M.P.	NS	129.6		**	123.7		NS	128.9		NS	124.5	
	L.P.	*	NS	128.3	**	NS	123.4	NS	NS	129.5	NS	NS	124.0
Leg length	H.P.	354			351			366			364		
	M.P.	NS	367		NS	349		NS	376		NS	363	
	L.P.	NS	*	350	NS	NS	342	NS	NS	368	NS	NS	359
Tibia length	H.P.	194.9			187.5			198.2			191.5		
	M.P.	NS	190.8		NS	183.8		NS	192.8		NS	188.7	
	L.P.	**	*	185.4	NS	NS	177.4	NS	NS	189.7	NS	NS	184.3

+ Number of animals in brackets.
*** = Significant at the 0.1% level of probability.
** = " " " 1% " "

* Significant at the 5% level of probability.
NS = Non-significant.

Table 31 (contd.)

Heavy and light hoggs prior to treatment. Adjusted mean live measurements and significance of differences between them over summer after treatment, 12 - 18 months.

Born 1956

N.C.C.

		57 weeks						80 weeks					
		Heavy			Light			Heavy			Light		
		H.P.(5)+	M.P.(5)	L.P.(5)	H.P.(7)	M.P.(7)	L.P.(6)	H.P.(5)	M.P.(5)	L.P.(5)	H.P.(7)	M.P.(7)	L.P.(6)
Girth	H.P.	834			799			890			868		
	M.P.	*	778		*	762		**	840		NS	844	
	L.P.	**	NS	759	**	*	727	**	NS	832	*	*	797
Body length	H.P.	691			680			710			699		
	M.P.	NS	673		**	632		NS	707		***	664	
	L.P.	NS	NS	661	**	NS	616	NS	NS	706	***	NS	661
Pelvis length	H.P.	219.7			215.1			226.0			222.4		
	M.P.	*	213.4		**	208.7		NS	223.2		*	217.1	
	L.P.	**	NS	210.2	***	***	200.8	NS	NS	222.5	***	**	210.8
Pelvis width	H.P.	187.6			177.4			196.0			184.7		
	M.P.	**	170.8		NS	174.6		NS	183.9		NS	186.2	
	L.P.	**	NS	173.8	***	***	160.1	NS	NS	188.6	**	**	172.3
Cannon length	H.P.	138.5			135.8			136.9			132.9		
	M.P.	NS	137.4		NS	133.9		NS	137.7		NS	133.2	
	L.P.	NS	NS	136.7	NS	NS	132.1	NS	NS	138.0	NS	NS	131.3
Leg length	H.P.	382			367			397			383		
	M.P.	NS	378		NS	367		NS	389		NS	375	
	L.P.	NS	NS	377	NS	NS	362	NS	NS	398	NS	NS	384
Tibia length	H.P.	206.8			202.0			212.7			206.9		
	M.P.	NS	202.2		NS	199.0		NS	209.4		NS	202.8	
	L.P.	NS	NS	201.3	***	***	190.5	NS	NS	206.2	**	*	195.5

+ Number of animals in brackets.
*** = Significant at the 0.1% level of probability.
** = " " " 1% " " "
* Significant at the 5% level of probability.
NS = Non-significant.

Table 31a

Heavy and light hoggs prior to treatment. Adjusted mean live measurements and significance of differences between them over summer after treatment, 12 - 18 months.

Born 1957

S.C.C.

		57 weeks						79 weeks					
		Heavy			Light			Heavy			Light		
		H.P.(7)+	M.P.(4)	Hill(6)	H.P.(5)	M.P.(5)	Hill(4)	H.P.(7)	M.P.(4)	Hill(6)	H.P.(4)	M.P.(5)	Hill(4)
Girth	H.P.	728			718			791			794		
	M.P.	NS	704		**	679		NS	780		NS	764	
	Hill	*	NS	691	***	*	652	NS	NS	772	NS	NS	721
Body length	H.P.	642			638			690			666		
	M.P.	NS	651		NS	619		NS	690		NS	658	
	Hill	NS	NS	629	NS	NS	577	NS	NS	671	*	*	626
Pelvis length	H.P.	208.4			204.1			221.7			219.3		
	M.P.	NS	207.0		**	194.0		NS	216.7		**	208.4	
	Hill	***	***	196.9	***	*	186.4	*	NS	213.9	***	**	198.6
Pelvis width	H.P.	166.8			163.9			182.6			182.8		
	M.P.	NS	162.3		***	152.2		NS	183.4		**	169.7	
	Hill	***	**	154.8	***	NS	147.3	NS	NS	176.9	**	NS	164.8
Cannon length	H.P.	123.0			120.6			123.6			123.3		
	M.P.	NS	124.2		NS	119.6		NS	125.8		NS	120.7	
	Hill	NS	NS	122.2	NS	NS	118.6	NS	NS	125.5	NS	NS	120.4
Leg length	H.P.	360			348			359			349		
	M.P.	NS	357		NS	340		NS	362		NS	347	
	Hill	**	*	344	NS	NS	335	NS	NS	354	NS	NS	345
Tibia length	H.P.	182.8			179.3			186.5			183.4		
	M.P.	NS	185.8		NS	178.3		NS	189.5		NS	182.4	
	Hill	NS	NS	180.8	NS	NS	175.6	NS	NS	184.6	NS	NS	176.9

+ Number of animals in brackets.
*** = Significant at the 0.1% level of probability.
** = " " " 1% " " "
* Significant at the 5% level of probability.
NS = Non-significant.

Table 31a (contd.)

Heavy and light hoggs prior to treatment. Adjusted mean live measurements and significance of differences between them over summer after treatment, 12 - 18 months.

Born 1957

N.C.C.

		57 weeks Heavy H.P.(6)+	M.P.(8)	Hill(6)	57 weeks Light H.P.(7)	M.P.(5)	Hill(7)	79 weeks Heavy H.P.(6)	M.P.(8)	Hill(6)	79 weeks Light H.P.(7)	M.P.(5)	Hill(7)
Girth	H.P.	739			753			834			826		
	M.P.	NS	742		*	710		NS	826		NS	815	
	Hill	**	**	701	**	NS	688	NS	NS	796	NS	NS	791
Body length	H.P.	681			668			714			692		
	M.P.	**	648		NS	640		NS	695		NS	698	
	Hill	***	NS	629	*	NS	627	**	*	658	NS	NS	672
Pelvis length	H.P.	215.6			212.4			230.6			226.6		
	M.P.	NS	211.6		**	204.3		*	225.8		NS	221.8	
	Hill	***	***	198.9	***	**	194.5	***	**	218.0	**	*	212.4
Pelvis width	H.P.	167.4			167.0			186.6			183.0		
	M.P.	NS	164.1		*	157.9		NS	183.0		NS	178.8	
	Hill	***	***	151.0	***	**	146.7	***	**	172.3	**	*	167.4
Cannon length	H.P.	137.2			135.3			138.6			135.7		
	M.P.	NS	135.4		*	132.7		NS	137.4		NS	136.0	
	Hill	**	*	132.6	**	NS	130.4	NS	NS	135.0	NS	NS	134.8
Leg length	H.P.	390			380			402			389		
	M.P.	NS	386		NS	377		NS	396		NS	385	
	Hill	*	*	376	NS	NS	368	NS	NS	392	NS	NS	377
Tibia length	H.P.	207.4			199.5			211.7			201.4		
	M.P.	NS	202.6		NS	196.1		NS	207.3		NS	199.6	
	Hill	*	NS	196.8	NS	NS	193.0	*	NS	202.3	NS	NS	197.5

+ Number of animals in brackets.
*** = Significant at 0.1% level of probability.
** = " " 1% " " "
* Significant at 5% level of probability.
NS = Non-significant.

Table 31b

Heavy and light hoggs prior to treatment. Adjusted mean live measurements and significance of differences between them over summer after treatment, 12 - 18 months.

Born 1958

S.C.C.

	68 weeks				82 weeks			
	Heavy		Light		Heavy		Light	
	Away(8)+	Hill(7)	Away(5)	Hill(6)	Away(8)	Hill(7)	Away(5)	Hill(6)
Girth (Away / Hill	781 NS	768	764 NS	749	778 NS	773	754 NS	746
Body length (Away / Hill	680 *	659	677 NS	650	687 NS	672	692 **	659
Pelvis length (Away / Hill	213.7 NS	209.4	210.1 NS	206.8	215.9 NS	213.3	213.3 NS	209.3
Pelvis width (Away / Hill	178.5 *	171.0	172.8 NS	167.1	182.7 NS	176.8	176.2 NS	171.8
Cannon length (Away / Hill	128.6 NS	126.0	124.5 NS	125.7	128.4 NS	127.8	124.4 NS	126.7
Leg length (Away / Hill	352 *	357	355 NS	355	364 NS	359	359 NS	361
Tibia length (Away / Hill	185.8 NS	186.3	184.4 NS	182.5	190.7 NS	189.1	187.8 NS	186.5

+ Number of animals in brackets.
** = Significant at the 1% level of probability.
* Significant at the 5% level of probability.
NS = Non-significant.

Table 31b (contd.)

Heavy and light hoggs prior to treatment. Adjusted mean live measurements and significance of differences between them over summer after treatment, 12 - 18 months.

Born 1958

		68 weeks				N.C.C.	82 weeks			
		Heavy		Light			Heavy		Light	
		Away(9)+	Hill(6)	Away(6)	Hill(9)		Away(9)	Hill(6)	Away(6)	Hill(9)
Girth	Away	815		791			809		789	
	Hill	NS	787	NS	767		NS	791	NS	769
Body length	Away	697		703			704		713	
	Hill	NS	683	NS	677		NS	697	NS	693
Pelvis length	Away	223.6		222.0			225.3		222.5	
	Hill	**	217.9	*	215.0		*	219.2	NS	218.1
Pelvis width	Away	187.4		184.5			190.5		188.5	
	Hill	*	181.7	NS	180.0		NS	185.4	NS	186.0
Cannon length	Away	137.5		136.7			138.1		136.2	
	Hill	*	135.2	NS	134.1		*	135.3	NS	134.5
Leg length	Away	388		380			391		392	
	Hill	NS	384	NS	377		NS	387	*	382
Tibia length	Away	204.6		201.6			206.6		203.8	
	Hill	NS	201.3	NS	195.2		NS	203.8	NS	198.6

+ Number of animals in brackets.
** = Significant at the 1% level of probability.
* = Significant at the 5% level of probability.
NS = Non-significant.

in the light weight class. Between the H.P. and M.P. sub-groups in the heavy weight class only the difference in pelvis width was still significant, while in body length the difference had become significant. In the light weight class significant differences were still present between these two treatments in all measurements except leg length and tibia length. Between the M.P. and L.P. sub-groups, significant differences were still present in all measurements except body length and cannon length in the heavy weight class, while in the light weight class the only significant difference was in pelvis length.

At 18 months (80 weeks) in the S.C.C. breed, between the H.P. and L.P. sub-groups the only differences still significant in the heavy weight class were in girth and the two pelvis measurements, while in the light weight class the only significant differences were in the two pelvis measurements. Between the H.P. and M.P. sub-groups, significance had reappeared in girth in the heavy weight class but no other differences were significant, while in the light weight class significant differences were still present in the two pelvis measurements. Between the M.P. and L.P. sub-groups, only in pelvis length was there a significant difference in the heavy weight class, no differences being significant in any of the measurements in the light weight class.

In the N.C.C. breed at 57 weeks, only in girth and the two pelvis measurements were the differences between the H.P. and L.P. sub-groups significant in the heavy weight class. In the light weight class all measurements except cannon length and leg length were significantly different between these treatments, in the case of tibia length significance appearing for the first time, not having been so at 49 weeks. Between the H.P. and M.P. sub-groups, in the heavy weight class only in girth and the two pelvis measurements were the differences significant, while in the light weight class they were only significant in girth, body length and pelvis length. Between the M.P. and L.P. sub-groups there were no significant differences in any of the measurements in the heavy weight class, while in the light weight class significant differences were still present in the two pelvis measurements and had appeared in girth and tibia length.

At 18 months (80 weeks) in the N.C.C. breed, between the H.P. and L.P. sub-groups the only difference still significant in the heavy weight class was in girth, while in the light weight class significant differences were still present in all measurements except cannon length and leg length, as at 57 weeks. Between the H.P. and M.P. sub-groups the only significant difference in the heavy weight class was in girth, while in the light weight class only in body length and pelvis length were the differences significant. Between the M.P. and L.P. sub-groups there were no significant differences in any of the measurements in the heavy weight class, while in the light weight class the four measurements which were significantly different at 57 weeks were still so.

Born 1957. Over the first eight weeks after treatment the H.P. heavy sub-groups, S.C.C. and N.C.C. respectively, increased in size by a further 2.0% and 1.5%, compared with the H.P. light sub-groups, which increased by 3.2% and 1.4%, making the former 9.9% and 10.2% and the latter 13.5% and 12.2% larger at 57 weeks than they were prior to treatment. During this time both M.P. heavy sub-groups increased in size by a further 4.4% compared with the M.P. light sub-groups, S.C.C. and N.C.C. respectively, which increased by 4.2% and 4.6%, making the former both 8.3% and the latter 7.6% and 9.2% larger at 57 weeks than they were prior to treatment. In the Hill heavy sub-groups, S.C.C. and N.C.C. respectively, the increases in size during this time were 5.5% and 4.2%, compared with the Hill light sub-groups, which increased by 2.9% and 5.0%, making the former 5.6% and 3.7% and the latter 4.8% and 5.3% larger at 57 weeks than they were prior to treatment.

Generally, between 49 and 57 weeks, in the heavy weight class in both breeds the H.P. animals exhibited less relative gain than the M.P. and Hill animals, which differed only slightly, though more so in the S.C.C. breed than the N.C.C. breed. This was also the case in the N.C.C. light weight class but in the S.C.C. light weight class the picture was slightly different. The Hill animals showed the least relative gain largely on account of growth virtually ceasing in the three leg measurements and the H.P. animals showed greater relative gain than the general trends would indicate largely on account of the tremendous increase in body length, which had apparently failed to increase over the treatment period. As in the previous year these relative differences in growth as described by the measurements were closely related to the live weight changes discussed in the previous sections. With the exception of the two Hill groups, in general, both weight classes showed very similar relative gains in the other treatment groups in both breeds during this time. The S.C.C. Hill group has been discussed above, while in the N.C.C. Hill group the light animals showed slightly greater gain than the heavy.

Over the rest of the summer, from 57 - 79 weeks, the H.P. heavy sub-groups, S.C.C. and N.C.C. respectively, increased in size by a further 5.6% and 6.6%, compared with the H.P. light sub-groups, which increased by 6.1% and 5.4%, making the former 15.5% and 16.8% and the latter 19.6% and 17.6% larger at 18 months than they were at 5 months. During this time the M.P. heavy sub-groups, S.C.C. and N.C.C. respectively, increased in size by a further 6.0% and 6.7%, compared with the M.P. light sub-groups, which increased by 6.5% and 7.9%, making the former 14.3% and 15.0% and the latter 14.1% and 17.1% larger at 18 months than they were at 5 months. In the Hill heavy sub-groups, S.C.C. and N.C.C. respectively, the increases in size during this time were 7.0% and 7.3%, compared with the Hill light sub-groups, which increased by 7.4% and 8.0%, making the former 12.6% and 11.0% and the latter 12.2% and 13.3% larger at 18 months than they were at 5 months.

Generally, between 57 and 79 weeks, in the heavy weight class in both breeds the H.P. animals continued to show less relative gain than the Hill animals, while the M.P. animals now differed very little in relative gain from those in the H.P. sub-groups, being only slightly greater. In the S.C.C. light weight class this was now also the case but in the N.C.C. light weight class the picture remained the same as at 57 weeks, with the M.P. and Hill animals having similar relative gains, both greater than that of the H.P. animals. With the exception of the N.C.C. H.P. group, in general, the light animals showed slightly greater relative gains than the heavy in all treatment groups in both breeds during this time. In the N.C.C. H.P. group the relative gains were similar in both weight classes in all measurements except girth and body length where the heavy animals gained relatively more than the light. This was closely related to the live weight changes discussed earlier.

In the S.C.C. breed at 57 weeks the differences between the H.P. and Hill sub-groups were still significant in the heavy weight class only in girth, the two pelvis measurements and leg length and in the light weight class only in girth and the two pelvis measurements. Between the H.P. and M.P. sub-groups, no significant differences were still present in any of the measurements in the heavy weight class, while in the light weight class only the differences in girth and the two pelvis measurements were still significant. Between the M.P. and Hill sub-groups, significant differences were still present in the heavy weight class only in the two pelvis measurements and leg length, while in the light weight class, differences in girth and pelvis length still remained significant.

At 18 months (79 weeks) in the S.C.C. breed, between the H.P. and Hill sub-groups the only difference still significant in the heavy weight class was in pelvis length, while in the light weight class the differences in the two pelvis measurements were still significant and that in body length had become so. Between the H.P. and M.P. sub-groups there were no significant differences in any of the measurements in the heavy weight class, while in the light weight class significant differences were still present in the two pelvis measurements. Between the M.P. and Hill sub-groups there were no significant differences in any of the measurements in the heavy weight class, while in the light weight class significant differences were still present in body length and pelvis length.

In the N.C.C. breed at 57 weeks, between the H.P. and Hill sub-groups, significant differences were present in all measurements in the heavy weight class, that in leg length appearing for the first time, not having been so at 49 weeks. In the light weight class all measurements except leg length and tibia length were significantly different between these treatments. Between the H.P. and M.P. sub-groups, only in body length was there still a significant difference in the heavy weight class, while in the light weight class significant differences were still present in girth, the two pelvis measurements and cannon length. Between the M.P. and Hill sub-groups, in the heavy weight class significant differences were still present in girth and the two pelvis measurements and had appeared for the first time in cannon length and leg length. In the light weight class, only in the two pelvis measurements were significant differences still present between these treatments.

At 18 months (79 weeks) in the N.C.C. breed, between the H.P. and Hill sub-groups there were still significant differences in the heavy weight class in body length, the two pelvis measurements and tibia length, while in the light weight class only in the two pelvis measurements were significant differences still present. Between the H.P. and M.P. sub-groups, in the heavy weight class significance had reappeared in pelvis length but in no other measurements were the differences significant. In the light weight class no differences were significant in any of the measurements. Between the M.P. and Hill sub-groups there were still significant differences in the heavy weight class in the two pelvis measurements and significance had reappeared in body length. In the light weight class the differences between these treatments in the two pelvis measurements remained significant.

<u>Born 1958</u>. From 49 - 68 weeks, the Away heavy sub-groups, S.C.C. and

N.C.C. respectively, increased in size by a further 8.5% and 9.8%, compared with the Away light sub-groups, which increased by 10.4% and 11.5%, making the former 15.7% and 16.0% and the latter 17.6% and 19.9% larger at 68 weeks than they were prior to treatment. During this time both Hill heavy sub-groups increased in size by a further 11.7% compared with the Hill light sub-groups, S.C.C. and N.C.C. respectively, which increased by 13.3% and 13.7%, making the former 13.5% and 13.0% and the latter 15.4% and 16.4% larger at 68 weeks than they were prior to treatment.

Between 49 and 68 weeks, in both weight classes in both breeds the Hill animals exhibited greater relative gains than the Away animals. Also in both breeds the light animals showed greater relative gains than the heavy in both treatment groups during this time.

Over the second half of the summer, from 68 - 82 weeks, the Away heavy sub-groups, S.C.C. and N.C.C. respectively, increased in size by only a further 1.9% and 0.9%, compared with the Away light sub-groups, which increased by only 1.1% and 1.7%, making the former 17.6% and 16.9% and the latter 18.7% and 21.6% larger at 18 months than they were at 6 months. During this time the Hill heavy sub-groups, S.C.C. and N.C.C. respectively, increased in size by a further 1.7% and 1.1%, compared with the Hill light sub-groups, which increased by 1.7% in both breeds, making the former 15.2% and 14.1% and the latter 17.1% and 18.1% larger at 18 months than they were at 6 months.

Between 68 and 82 weeks, the relative gains in all sub-groups in both breeds were so small that there was little difference between the treatments or between the weight classes, only in the N.C.C. breed the light animals appearing to a small degree to gain relatively more than the heavy.

In the S.C.C. breed at 68 weeks there were still significant differences in the heavy weight class in girth and pelvis width while significance appeared in leg length for the first time, the Hill animals being longer than the Away.

In the light weight class there were no significant differences in any of the measurements.

At 18 months (82 weeks) in the S.C.C. breed there were no significant differences in any of the measurements in the heavy weight class, while in the light weight class significance had reappeared in body length but in no other measurements did the treatments differ significantly.

In the N.C.C. breed at 68 weeks there were still significant differences in the heavy weight class in the two pelvis measurements and cannon length, while in the light weight class the only difference still significant was in pelvis length.

At 18 months (82 weeks) in the N.C.C. breed there were still significant differences in the heavy weight class in pelvis length and cannon length, while in the light weight class significance had reappeared in leg length but in no other measurements did the treatments differ significantly.

3. From 18 months onwards

(a) Total groups. The actual mean live measurements recorded from 18 months onwards in the 1956 and 1957 born age groups are shown in Tables 32 and 32a. Total and percentage gains by each measurement from the start of the treatment period are shown to 27 and 39 months for the 1956 born age group in Table 33 and to 27 months for the 1957 born age group in Table 33a. Adjusted means from covariance analysis and the significance of differences between them are shown in Tables 34 and 34a. With growth slowing up considerably after 18 months it was decided to measure the animals only once a year. To avoid the complications of pregnancy in the spring and excess condition in the autumn the time selected for these measurements was mid-summer, shortly after clipping time, the absence of wool making it easier to record the body measurements.

Born 1956. Between 18 and 27 months the S.C.C. H.P. group did not alter in size as described by the average gain of the seven live measurements, while the N.C.C. H.P. group diminished in size by 0.8%, making the former 16.3% and and the latter 15.9% larger at 27 months than they were at 6 months. In both

Table 32

Mean live measurements from 18 months onwards (mms.)

Born 1956

	S.C.C.									N.C.C.								
	18 months			27 months			39 months			18 months			27 months			39 months		
	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.
Girth	835	796	797	791	775	767	864	804	806	859	840	815	807	809	785	856	866	853
Body length	673	647	648	678	663	674	708	687	694	700	682	685	700	696	691	726	719	714
Pelvis length	216	208	206	216	214	211	224	218	215	224	220	216	224	222	220	228	228	226
Pelvis width	180	173	173	184	182	183	194	189	191	187	187	181	191	195	189	201	207	202
Cannon length	130	126	127	133	127	129	132	127	127	134	135	134	136	136	135	136	137	135
Leg length	372	362	364	370	361	365	371	363	366	390	382	387	387	383	384	386	387	386
Tibia Length	194	189	189	194	189	189	198	195	192	208	204	203	205	203	201	207	207	207

Table 32a

Mean live measurements from 18 months onwards (mms.)

Born 1957

	S.C.C.						N.C.C.					
	18 months			27 months			18 months			27 months		
	H.P.	M.P.	Hill	H.P.	M.P.	Hill	H.P.	M.P.	Hill	H.P.	M.P.	Hill
Girth	793	771	751	799	776	776	830	821	793	823	821	809
Body length	679	675	653	693	700	674	703	696	665	720	722	698
Pelvis length	220	214	207	221	216	213	228	225	215	226	227	221
Pelvis width	183	176	172	191	183	184	185	182	169	189	192	183
Cannon length	122	123	124	124	124	126	137	137	135	138	138	137
Leg length	353	354	353	353	357	356	395	393	383	390	390	387
Tibia length	184	187	181	186	189	187	207	205	199	209	209	203

Table 33

Actual and percentage gain in mean live measurements from start of treatment period at 27 weeks to 27 and 39 months. Actual gain in mms. Percentage gain in brackets.

Born 1956

	S.C.C.						N.C.C.					
	27 months			39 months			27 months			39 months		
	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.
Girth	113(16.7)	104(15.5)	93(13.8)	186(27.4)	133(19.8)	132(19.6)	98(13.8)	98(13.8)	59(8.1)	147(20.7)	155(21.8)	127(17.5)
Body length	99(17.1)	87(15.1)	95(16.4)	129(22.3)	111(19.3)	115(19.9)	114(19.5)	93(15.4)	76(12.4)	140(23.9)	116(19.2)	99(16.1)
Pelvis length	30(16.1)	30(16.3)	26(14.1)	38(20.4)	34(18.5)	30(16.2)	33(17.3)	30(15.6)	30(15.8)	37(19.4)	36(18.8)	36(18.9)
Pelvis width	38(26.0)	36(24.7)	36(24.5)	48(32.9)	43(29.5)	44(29.9)	41(27.3)	41(26.6)	35(22.7)	51(34.0)	53(34.4)	48(31.2)
Cannon length	13(10.8)	9(7.6)	10(8.4)	12(10.0)	9(7.6)	8(6.7)	11(8.8)	10(7.9)	10(8.0)	11(8.8)	11(8.7)	10(8.0)
Leg length	49(15.3)	50(16.1)	46(14.4)	50(15.6)	52(16.7)	47(14.7)	41(11.8)	35(10.0)	44(12.9)	40(11.6)	39(11.2)	46(13.5)
Tibia length	21(12.1)	17(9.9)	14(8.0)	25(14.5)	23(13.4)	17(9.7)	23(12.6)	21(11.5)	15(8.1)	25(13.7)	25(13.7)	21(11.3)
Mean % gain	16.3	15.0	14.2	20.4	17.8	16.7	15.9	14.4	12.6	18.9	18.3	16.6

Table 33a

Actual and percentage gain in mean live measurements from start of treatment period at 22 weeks to 27 months. Actual gain in mms. Percentage gain in brackets.

Born 1957

	S.C.C. 27 months			N.C.C. 27 months		
	H.P.	M.P.	Hill	H.P.	M.P.	Hill
Girth	123(18.2)	104(15.5)	107(16.0)	117(16.6)	119(17.0)	102(14.4)
Body length	122(21.4)	109(18.4)	92(15.8)	117(19.4)	121(20.1)	99(16.5)
Pelvis length	39(21.4)	31(16.8)	31(17.0)	37(19.6)	36(18.8)	31(16.3)
Pelvis width	51(36.4)	43(30.7)	43(30.5)	46(32.2)	49(34.3)	41(28.9)
Cannon length	12(10.7)	10(8.8)	13(11.5)	14(11.3)	14(11.3)	14(11.4)
Leg length	35(11.0)	36(11.2)	33(10.2)	41(11.7)	38(10.8)	40(11.5)
Tibia length	21(12.7)	20(11.8)	21(12.7)	28(15.5)	27(14.8)	23(12.8)
Mean % gain	18.8	16.2	16.2	18.0	18.2	16.0

breeds growth virtually ceased in all measurements except girth and pelvis width. Girth diminished considerably during this time and was responsible for the apparent reduction in size of the N.C.C. animals, while pelvis width continued to increase in both breeds. During this time the M.P. groups, S.C.C. and N.C.C. respectively, increased in size by a further 1.4% and 0.7%, making them 15.0% and 14.4% larger at 27 months than they were at 6 months. Here also girth had diminished in both breeds and disguised a continued increase in the other three body measurements, particularly pelvis width, while growth had ceased in the three leg measurements. In the L.P. groups, S.C.C. and N.C.C. respectively, the increase in size during this time was 1.6% and 0.5%, making them 14.2% and 12.6% larger at 27 months than they were at 6 months. Here again girth had diminished and disguised continued body growth with no leg growth.

In the course of the year between 27 and 39 months the H.P. groups, S.C.C. and N.C.C. respectively, increased in size by a further 4.1% and 3.0%, making them 20.4% and 18.9% larger at 39 months than they were at 6 months. All measurements except cannon length and leg length increased during this time in both breeds and excluding girth, the greatest relative increase was still in pelvis width. During this time the M.P. groups, S.C.C. and N.C.C. respectively, increased in size by a further 2.8% and 3.9%, making them 17.8% and 18.3% larger at 39 months than they were at 6 months. In the S.C.C. breed, all measurements except cannon length increased, although leg length increase was very small, while pelvis width again showed the greatest relative increase. In the N.C.C. breed, all measurements increased, cannon length and leg length only to a limited extent, while excluding girth, pelvis width showed the greatest relative increase. The L.P. groups, S.C.C. and N.C.C. respectively, increased in size during this time by a further 2.5% and 4.0%, making them 16.7% and 16.0% larger at 39 months than they were at 6 months. In both breeds, all measurements except cannon length increased, though leg length increase was again very small, while excluding girth, pelvis width showed the greatest relative increase.

Table 34

Adjusted mean live measurements and significance of differences between them at 27 and 39 months.

Born 1956

		S.C.C. 27 months H.P.(8)+	S.C.C. 27 months M.P.(9)	S.C.C. 27 months L.P.(11)	S.C.C. 39 months H.P.(8)	S.C.C. 39 months M.P.(9)	S.C.C. 39 months L.P.(11)	N.C.C. 27 months H.P.(10)	N.C.C. 27 months M.P.(9)	N.C.C. 27 months L.P.(10)	N.C.C. 39 months H.P.(10)	N.C.C. 39 months M.P.(9)	N.C.C. 39 months L.P.(10)
Girth	H.P.	790			855			814			862		
	M.P.	NS	776		NS	812		NS	808		NS	865	
	L.P.	NS	NS	767	NS	NS	806	NS	NS	778	NS	NS	847
Body length	H.P.	676			706			709			733		
	M.P.	NS	670		NS	696		NS	697		NS	719	
	L.P.	NS	NS	670	NS	NS	689	*	NS	681	*	NS	706
Pelvis length	H.P.	214.7			222.3			224.7			228.7		
	M.P.	NS	215.7		NS	220.1		NS	221.6		NS	227.8	
	L.P.	NS	NS	211.2	*	NS	215.1	NS	NS	220.0	NS	NS	226.3
Pelvis width	H.P.	184.2			193.8			193.4			204.0		
	M.P.	NS	182.6		NS	190.4		NS	193.4		NS	205.6	
	L.P.	NS	NS	181.9	NS	NS	190.3	NS	NS	186.9	NS	NS	200.0
Cannon length	H.P.	130.6			129.5			136.9			136.3		
	M.P.	NS	128.3		NS	128.8		NS	134.9		NS	135.7	
	L.P.	NS	NS	129.9	NS	NS	127.4	NS	NS	135.0	NS	NS	135.1
Leg length	H.P.	362			363			385			385		
	M.P.	NS	368		NS	370		NS	382		NS	386	
	L.P.	NS	NS	364	NS	NS	366	NS	NS	388	NS	NS	389
Tibia length	H.P.	192.9			197.0			206.3			208.9		
	M.P.	NS	191.2		NS	197.1		NS	203.7		NS	207.8	
	L.P.	NS	NS	188.2	*	*	191.2	**	*	199.1	NS	NS	204.6

+ Number of animals in brackets.
** = Significant at the 1% level of probability.
* = Significant at the 5% level of probability.
NS = Non-significant.

Table 34a

Adjusted mean live measurements and significance of differences between them at 27 months.

Born 1957

		S.C.C.			N.C.C.		
		H.P.(10)+	M.P.(8)	Hill(9)	H.P.(11)	M.P.(12)	Hill(12)
Girth	H.P.	793			823		
	M.P.	NS	776		NS	822	
	Hill	NS	NS	781	NS	NS	809
Body length	H.P.	698			718		
	M.P.	NS	693		NS	721	
	Hill	NS	NS	674	*	*	700
Pelvis length	H.P.	220.6			227.5		
	M.P.	NS	216.0		NS	225.7	
	Hill	NS	NS	214.1	NS	NS	221.0
Pelvis width	H.P.	189.4			188.9		
	M.P.	NS	184.4		NS	190.9	
	Hill	NS	NS	184.2	NS	NS	183.8
Cannon length	H.P.	124.4			138.2		
	M.P.	NS	124.5		NS	137.7	
	Hill	NS	NS	124.9	NS	NS	137.1
Leg length	H.P.	355			391		
	M.P.	NS	357		NS	387	
	Hill	NS	NS	352	NS	NS	388
Tibia length	H.P.	187.4			208.9		
	M.P.	NS	187.1		NS	208.1	
	Hill	NS	NS	187.2	NS	NS	204.7

+ Number of animals in brackets.
* = Significant at the 5% level of probability.
NS = Non-significant.

In the S.C.C. breed at 27 months, although the differences that remained were generally in favour of the better rearing treatments, none were still significant. However, by 39 months, significant differences had reappeared between the H.P. and L.P. groups in pelvis length and tibia length and between the M.P. and L.P. groups in tibia length alone. In the N.C.C. breed at 27 months, significant differences were still present between the H.P. and L.P. groups in body length and tibia length and between the M.P. and L.P. groups in tibia length alone and although generally there were differences in the other measurements in favour of the better rearing treatments, it was not possible to prove them significant. At 39 months the only significant difference still present in this breed was between the H.P. and L.P. groups in body length.

Born 1957. Between 18 and 27 months the H.P. groups, S.C.C. and N.C.C. respectively, increased in size by a further 1.8% and 0.5%, making them 18.8% and 18.0% larger at 27 months than they were at 5 months. Excluding girth, which gained very slightly in the S.C.C. breed and lost very slightly in the N.C.C. breed, all measurements except pelvis length and leg length increased in both breeds during this time, with pelvis width showing the greatest relative increase, although in the N.C.C. breed body length increased by the same relative amount. During this time the M.P. groups, S.C.C. and N.C.C. respectively, increased in size by a further 2.0% and 2.1%, making them 16.2% and 18.2% larger at 27 months than they were at 5 months. Excluding girth which in both breeds remained virtually unchanged, in the S.C.C. breed, all measurements increased, although only to a limited extent in pelvis length and cannon length, with pelvis width again showing the greatest relative increase. In the N.C.C. breed, all measurements except leg length increased, although only to a limited extent in pelvis length and cannon length, with pelvis width again showing the greatest relative increase. The Hill groups, S.C.C. and N.C.C. respectively, increased in size during this time by a further 3.6% and 3.7%, making them 16.2% and 16.0% larger at 27 months than they were at 5 months. All measurements in both breeds increased, with pelvis width in particular showing a very considerable relative increase compared to the other measurements, amongst which the least relative increase was shown by leg length.

In the S.C.C. breed at 27 months there were no differences between any of the treatment means in the three leg measurements and while there were still small differences generally in favour of the better rearing treatments in the body measurements, none of them were significant. In the N.C.C. breed, although there were still differences in favour of the better rearing treatments in all measurements, only in body length was it possible to prove significance, the Hill animals being significantly smaller than those of both the other two groups.

(b) Heavy and light hoggs prior to treatment. The actual mean live measurements recorded from 18 months onwards in the 1956 and 1957 born age groups are shown in Tables 35 and 35a. Total and percentage gains by each measurement in both weight classes from the start of the treatment period are shown to 27 and 39 months for the 1956 born age group in Table 36 and to 27 months for the 1957 born age group in Table 36a. Adjusted means from covariance analysis and the significance of differences between them in each weight class are shown in Tables 37 and 37a.

Born 1956. Between 18 and 27 months the H.P. heavy sub-groups, S.C.C. and N.C.C. respectively, decreased in size by 0.4% and 1.0%, compared with the H.P. light sub-groups, which decreased by 1.2% and 0.5%, making the former 14.4% and 14.7% and the latter 17.9% and 16.3% larger at 27 months than they were at 6 months. In both weight classes in both breeds this was due to a considerable reduction in girth, particularly in the light weight class, while growth ceased in most of the other measurements, many of which showed a reduction due to loss of tissue cover. Only pelvis width continued to increase consistently in both weight classes. During this time the M.P. heavy sub-groups, S.C.C. and N.C.C. respectively, increased in size by a further 2.8% and 1.6%, compared with the M.P. light sub-groups, which increased by only 0.8% and 0.6%, making the former

Table 35

Mean live measurements from 18 months onwards of heavy and light hoggs prior to treatment (mms.)

Born 1956

		S.C.C.									N.C.C.								
		18 months			27 months			39 months			18 months			27 months			39 months		
		H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.
Girth	(Heavy	836	801	796	797	803	769	877	852	811	890	837	834	813	835	811	899	897	871
	(Light	834	793	801	782	761	764	843	780	796	837	842	800	803	796	758	827	850	835
Body length	(Heavy	683	653	648	683	678	673	722	707	699	709	707	706	719	723	710	733	752	736
	(Light	664	644	649	670	655	676	685	678	685	694	665	668	687	683	671	722	703	691
Pelvis length	(Heavy	219	213	206	218	220	212	226	225	217	226	224	222	225	231	226	232	236	231
	(Light	212	206	206	213	211	210	220	215	213	223	217	211	224	218	213	226	225	221
Pelvis width	(Heavy	184	177	173	186	191	184	196	199	193	192	186	190	197	195	198	212	206	211
	(Light	177	171	173	181	177	181	190	185	189	183	187	174	186	195	180	194	207	193
Cannon length	(Heavy	132	128	128	136	130	132	135	130	129	137	139	136	139	139	137	139	140	137
	(Light	129	124	125	127	126	126	126	126	123	132	133	133	135	134	132	134	135	132
Leg length	(Heavy	376	368	366	376	367	366	374	367	369	394	396	394	390	395	393	390	403	394
	(Light	368	359	361	360	358	361	367	361	361	386	373	382	384	378	376	383	379	378
Tibia length	(Heavy	198	193	190	196	194	190	200	198	194	211	211	206	209	211	204	212	214	211
	(Light	191	187	188	190	187	188	194	194	190	206	200	201	202	200	199	204	204	203

Table 35a

Mean live measurements from 18 months onwards of heavy and light hoggs prior to treatment (mms.)

Born 1957

		S.C.C.						N.C.C.					
		18 months			27 months			18 months			27 months		
		H.P.	M.P.	Hill	H.P.	M.P.	Hill	H.P.	M.P.	Hill	H.P.	M.P.	Hill
Girth	(Heavy	791	779	773	799	781	817	834	826	796	833	836	835
	(Light	795	765	719	798	771	725	827	814	791	815	791	791
Body length	(Heavy	689	693	671	704	714	694	718	696	652	723	729	698
	(Light	661	661	628	667	686	650	691	695	676	717	709	699
Pelvis length	(Heavy	222	218	213	222	222	220	231	226	218	231	229	225
	(Light	217	210	198	219	211	205	225	224	213	223	224	218
Pelvis width	(Heavy	184	183	175	192	190	189	188	182	172	193	191	189
	(Light	182	170	166	189	176	179	182	181	166	186	193	178
Cannon length	(Heavy	123	128	125	124	128	126	140	137	135	141	138	139
	(Light	122	120	123	123	121	125	136	137	134	136	139	135
Leg length	(Heavy	354	365	358	356	365	361	403	397	390	401	390	394
	(Light	350	346	346	345	349	349	387	387	377	380	389	381
Tibia length	(Heavy	185	194	184	187	196	191	212	208	201	214	212	205
	(Light	183	182	178	185	182	182	202	199	197	205	205	202

Table 36

Actual and percentage gain in mean live measurements of heavy and light hoggs prior to treatment from start of treatment period at 27 weeks to 27 and 39 months. Actual gain in mms. Percentage gain in brackets.

Born 1956

S.C.C.

		27 months			39 months		
		H.P.	M.P.	L.P.	H.P.	M.P.	L.P.
Girth	(H.	100(14.3)	106(15.2)	77(11.1)	180(25.8)	155(22.2)	119(17.2)
	(L.	125(19.0)	111(17.1)	116(17.9)	186(28.3)	130(20.0)	148(22.8)
Body length	(H.	90(15.2)	90(15.3)	92(15.8)	129(21.8)	119(20.2)	118(20.3)
	(L.	107(19.0)	89(15.7)	100(17.4)	122(21.7)	112(19.8)	109(18.9)
Pelvis length	(H.	26(13.5)	32(17.0)	26(14.0)	34(17.7)	37(19.7)	31(16.7)
	(L.	34(19.0)	31(17.2)	26(14.1)	41(22.9)	35(19.4)	29(15.8)
Pelvis width	(H.	35(23.2)	41(27.3)	33(21.9)	45(29.8)	49(32.7)	42(27.8)
	(L.	42(30.2)	35(24.6)	39(27.5)	51(36.7)	43(30.3)	47(33.1)
Cannon length	(H.	11(8.8)	10(8.3)	11(9.1)	10(8.0)	10(8.3)	8(6.6)
	(L.	12(10.4)	10(8.6)	10(8.6)	11(9.6)	10(8.6)	7(6.0)
Leg length	(H.	49(15.0)	50(15.8)	45(14.0)	47(14.4)	50(15.8)	48(15.0)
	(L.	46(14.6)	51(16.6)	45(14.2)	53(16.9)	54(17.6)	45(14.2)
Tibia length	(H.	19(10.7)	17(9.6)	13(7.3)	23(13.0)	21(11.9)	17(9.6)
	(L.	22(13.1)	20(12.0)	17(9.9)	26(15.5)	27(16.2)	19(11.1)
Mean % gain	(H.	14.4	15.5	13.3	18.6	18.7	16.2
	(L.	17.9	16.0	15.7	21.7	18.8	17.4

H. = Heavy
L. = Light

Table 36 (contd.)

Actual and percentage gain in mean live measurements of heavy and light hoggs prior to treatment from start of treatment period at 27 weeks to 27 and 39 months. Actual gain in mms. Percentage gain in brackets.

Born 1956

N.C.C.

		27 months			39 months		
		H.P.	M.P.	L.P.	H.P.	M.P.	L.P.
Girth	(H.	76(10.3)	104(14.2)	69(9.3)	162(22.0)	166(22.7)	129(17.4)
	(L.	112(16.2)	98(14.0)	44(6.2)	136(19.7)	152(21.8)	121(16.9)
Body length	(H.	108(17.7)	98(15.7)	78(12.3)	122(20.0)	127(20.3)	104(16.5)
	(L.	117(20.5)	94(16.0)	68(11.3)	152(26.7)	114(19.4)	88(14.6)
Pelvis length	(H.	30(15.4)	32(16.1)	34(17.7)	37(19.0)	37(18.6)	39(20.3)
	(L.	34(17.9)	31(16.6)	25(13.3)	36(18.9)	38(20.3)	33(17.6)
Pelvis width	(H.	42(27.1)	35(21.9)	39(24.5)	57(36.8)	46(28.8)	52(32.7)
	(L.	39(26.5)	45(30.0)	30(20.0)	47(32.0)	57(38.0)	43(28.7)
Cannon length	(H.	10(7.8)	9(6.9)	11(8.7)	10(7.8)	10(7.7)	11(8.7)
	(L.	12(9.8)	11(8.9)	7(5.6)	11(8.9)	12(9.8)	7(5.6)
Leg length	(H.	43(12.4)	36(10.0)	47(13.6)	43(12.4)	44(12.3)	48(13.9)
	(L.	39(11.3)	37(10.9)	41(12.2)	38(11.0)	38(11.1)	43(12.8)
Tibia length	(H.	23(12.4)	22(11.6)	17(9.1)	26(14.0)	25(13.2)	24(12.8)
	(L.	21(11.6)	22(12.4)	14(7.6)	23(12.7)	26(14.6)	18(9.7)
Mean % gain	(H.	14.7	13.8	13.6	18.9	17.7	17.5
	(L.	16.3	15.5	10.9	18.6	19.3	15.1

H. = Heavy
L. = Light

Table 36a

Actual and percentage gain in mean live measurements of heavy and light hoggs prior to treatment from start of treatment period at 22 weeks to 27 months. Actual gain in mms. Percentage gain in brackets.

Born 1957

		S.C.C. 27 months			N.C.C. 27 months		
		H.P.	M.P.	Hill	H.P.	M.P.	Hill
Girth	(H.	113(16.5)	93(13.5)	127(18.4)	115(16.0)	120(16.8)	114(15.8)
	(L.	138(20.9)	111(16.8)	85(13.3)	118(16.9)	108(15.8)	95(13.6)
Body length	(H.	120(20.5)	96(15.5)	98(16.4)	106(17.2)	116(18.9)	96(15.9)
	(L.	118(21.5)	115(20.1)	89(15.9)	124(20.9)	125(21.4)	103(17.3)
Pelvis length	(H.	35(18.7)	33(17.5)	34(18.2)	38(19.7)	36(18.7)	32(16.6)
	(L.	45(25.9)	29(15.9)	28(15.8)	37(19.9)	36(19.1)	31(16.6)
Pelvis width	(H.	47(32.4)	46(31.9)	46(32.2)	45(30.4)	46(31.7)	42(28.6)
	(L.	55(41.0)	39(28.5)	40(28.8)	47(33.8)	52(36.9)	40(29.0)
Cannon length	(H.	10(8.8)	11(9.4)	11(9.6)	15(11.9)	14(11.3)	14(11.2)
	(L.	14(12.8)	10(9.0)	13(11.6)	13(10.6)	15(12.1)	14(11.6)
Leg length	(H.	35(10.9)	39(12.0)	31(9.4)	44(12.3)	34(9.6)	42(11.9)
	(L.	31(9.9)	31(9.7)	36(11.5)	37(10.8)	41(11.8)	37(10.8)
Tibia length	(H.	21(12.7)	21(12.0)	23(13.7)	29(15.7)	26(14.0)	22(12.0)
	(L.	22(13.5)	17(10.3)	20(12.3)	26(14.5)	28(15.8)	25(14.1)
Mean % gain	(H.	17.2	16.0	16.8	17.6	17.3	16.0
	(L.	20.8	15.8	15.6	18.2	19.0	16.1

H = Heavy
L = Light

15.5% and 13.8% and the latter 16.0% and 15.5% larger at 27 months than they were at 6 months. In both weight classes in both breeds, excluding girth, most measurements increased during this time, although only to a very limited extent in some of the leg measurements. Pelvis width showed the greatest relative increase in both weight classes and was particularly high in the S.C.C. heavy weight class. Most of the difference in mean relative increase between the weight classes was, however, due to girth, which was virtually maintained in the heavy animals but was considerably reduced in the light. In the L.P. heavy sub-groups, S.C.C. and N.C.C. respectively, the increases in size during this time were 2.0% and 0.6%, compared with the L.P. light sub-groups, where the S.C.C. animals increased by 1.1% and the N.C.C. animals decreased by 0.5%, making the heavy sub-groups 13.3% and 13.6% and the light sub-groups 15.7% and 10.9% larger at 27 months than they were at 6 months. In both weight classes in both breeds, girth decreased during this time, to a greater extent in the light animals, while the other body measurements increased, with pelvis width showing the greatest relative increase. The only leg measurement to show any increase was cannon length, particularly in the heavy weight class.

In the course of the year between 27 and 39 months the H.P. heavy sub-groups in both breeds increased in size by a further 4.2%, compared with the H.P. light sub-groups, S.C.C. and N.C.C. respectively, which increased by 3.8% and 2.3%, making the former 18.6% and 18.9% and the latter 21.7% and 18.6% larger at 39 months than they were at 6 months. In both weight classes in both breeds the four body measurements and tibia length increased during this time, while cannon length and leg length growth ceased, except in the S.C.C. light sub-group where leg length apparently continued to increase. Excluding girth, in which the heavy animals increased relatively very much more than the light, the greatest relative increase in both weight classes was in pelvis width. During this time the M.P. heavy sub-groups, S.C.C. and N.C.C. respectively, increased in size by a further 3.2% and 3.9%, compared with the M.P. light sub-groups, which increased by 2.8%

and 3.8%, making the former 18.7% and 17.7% and the latter 18.8% and 19.3% larger at 39 months than they were at 6 months. In the S.C.C. breed, all measurements except cannon length in both weight classes and leg length in the heavy weight class, increased during this time, while in the N.C.C. breed all measurements increased in both weight classes. Girth again showed much greater relative increase in the heavy animals and of the other measurements pelvis width continued to show the greatest relative increase in both weight classes. The L.P. heavy sub-groups, S.C.C. and N.C.C. respectively, increased in size during this time by a further 2.9% and 3.9%, compared with the L.P. light sub-groups, which increased by 1.7% and 4.2%, making the former 16.2% and 17.5% and the latter 17.4% and 15.1% larger at 39 months than they were at 6 months. In both weight classes in both breeds, all measurements except cannon length and the S.C.C. light leg length increased during this time. Excluding girth, which showed a slightly smaller relative difference between the weight classes compared with the other treatments, pelvis width once more showed the greatest relative increase in both weight classes.

In the S.C.C. breed at 27 months there were no significant differences present between the treatments in any of the measurements in either weight class, although the differences that remained were still sizable in girth and the two pelvis measurements in both weight classes and in tibia length in the heavy weight class. At 39 months there were still no significant differences in any of the measurements although some of the differences between treatments were greater at this time than they were at 27 months, particularly in the light weight class in girth, the two pelvis measurements and tibia length. In the N.C.C. breed at 27 months there were no significant differences present between the treatments in any of the measurements in the heavy weight class, although the differences that remained were still sizable in pelvis length and tibia length. In the light weight class, however, the differences between the H.P. and L.P. animals in girth and pelvis length and between the M.P. and L.P. animals in girth and

Table 37

Heavy and light hoggs prior to treatment. Adjusted mean live measurements and significance of differences between them at 27 and 39 months.

Born 1956

S.C.C.

		27 months						39 months					
		Heavy			Light			Heavy			Light		
		H.P.(5)+	M.P.(3)	L.P.(7)	H.P.(3)	M.P.(6)	L.P.(4)	H.P.(5)	M.P.(3)	L.P.(7)	H.P.(3)	M.P.(6)	L.P.(4)
Girth	H.P.	797			792			875			840		
	M.P.	NS	803		NS	758		NS	846		NS	781	
	L.P.	NS	NS	768	NS	NS	761	NS	NS	821	NS	NS	797
Body length	H.P.	680			674			721			686		
	M.P.	NS	681		NS	660		NS	708		NS	679	
	L.P.	NS	NS	674	NS	NS	666	NS	NS	699	NS	NS	683
Pelvis length	H.P.	215.4			214.7			223.1			220.8		
	M.P.	NS	219.6		NS	212.1		NS	224.2		NS	215.5	
	L.P.	NS	NS	214.3	NS	NS	207.2	NS	NS	219.5	NS	NS	211.2
Pelvis width	H.P.	185.6			185.4			195.8			194.9		
	M.P.	NS	191.2		NS	176.4		NS	198.5		NS	183.7	
	L.P.	NS	NS	184.0	NS	NS	178.3	NS	NS	193.2	NS	NS	185.8
Cannon length	H.P.	134.4			127.3			132.1			126.8		
	M.P.	NS	130.4		NS	125.3		NS	131.2		NS	125.8	
	L.P.	NS	NS	132.7	NS	NS	125.5	NS	NS	130.9	NS	NS	122.8
Leg length	H.P.	367			356			363			363		
	M.P.	NS	375		NS	361		NS	378		NS	364	
	L.P.	NS	NS	368	NS	NS	359	NS	NS	373	NS	NS	358
Tibia length	H.P.	197.2			186.8			200.9			191.2		
	M.P.	NS	192.5		NS	189.0		NS	197.2		NS	195.7	
	L.P.	NS	NS	190.1	NS	NS	188.7	NS	NS	193.4	NS	NS	188.6

+ Number of animals in brackets.
NS = Non-significant.

Table 37 (contd.)

Heavy and light hoggs prior to treatment. Adjusted mean live measurements and significance of differences between them at 27 and 39 months.

Born 1956

N.C.C.

		27 months						39 months					
		Heavy			Light			Heavy			Light		
		H.P.(4)+	M.P.(3)	L.P.(5)	H.P.(6)	M.P.(6)	L.P.(5)	H.P.(4)	M.P.(3)	L.P.(5)	H.P.(6)	M.P.(6)	L.P.(5)
Girth	H.P.	814			809			894			830		
	M.P.	NS	834		NS	796		NS	900		NS	850	
	L.P.	NS	NS	810	*	*	751	NS	NS	873	NS	NS	831
Body length	H.P.	718			697			733			727		
	M.P.	NS	723		NS	681		NS	752		**	702	
	L.P.	NS	NS	711	NS	NS	663	NS	NS	736	**	NS	686
Pelvis length	H.P.	227.4			223.1			233.8			225.2		
	M.P.	NS	224.1		NS	219.4		NS	231.9		NS	225.4	
	L.P.	NS	NS	227.9	*	NS	213.2	NS	NS	232.5	NS	NS	220.9
Pelvis width	H.P.	202.4			187.9			218.0			195.3		
	M.P.	NS	190.1		NS	193.4		NS	201.3		*	206.2	
	L.P.	NS	NS	196.2	NS	*	180.1	NS	NS	208.6	NS	*	192.9
Cannon length	H.P.	138.7			135.6			139.5			134.2		
	M.P.	NS	135.4		NS	133.7		NS	135.7		NS	134.7	
	L.P.	NS	NS	139.4	NS	NS	131.8	NS	NS	139.3	NS	NS	132.0
Leg length	H.P.	393			380			392			380		
	M.P.	NS	386		NS	378		NS	397		NS	379	
	L.P.	NS	NS	396	NS	NS	381	NS	NS	396	NS	NS	382
Tibia length	H.P.	212.2			202.5			214.8			205.0		
	M.P.	NS	205.0		NS	201.7		NS	208.7		NS	206.6	
	L.P.	NS	NS	204.2	NS	NS	195.4	NS	NS	211.2	NS	NS	199.0

+ Number of animals in brackets.

** = Significant at the 1% level of probability.

* = Significant at the 5% level of probability.

NS = Non-significant.

Table 37a

Heavy and light hoggs prior to treatment. Adjusted mean live measurements and significance of differences between them at 27 months.

		S.C.C. Heavy H.P.(7)+	S.C.C. Heavy M.P.(4)	S.C.C. Heavy Hill(5)	S.C.C. Light H.P.(3)	S.C.C. Light M.P.(4)	S.C.C. Light Hill(4)	N.C.C. Heavy H.P.(5)	N.C.C. Heavy M.P.(8)	N.C.C. Heavy Hill(5)	N.C.C. Light H.P.(6)	N.C.C. Light M.P.(4)	N.C.C. Light Hill(7)
Girth	H.P.	800			810			833			814		
	M.P.	NS	782		NS	774		NS	836		NS	788	
	Hill	NS	NS	815	**	**	715	NS	NS	835	NS	NS	791
Body length	H.P.	708			660			720			718		
	M.P.	NS	707		NS	691		NS	729		NS	711	
	Hill	NS	NS	694	NS	*	651	*	***	703	NS	NS	696
Pelvis length	H.P.	221.8			217.8			230.5			224.6		
	M.P.	NS	219.8		NS	212.0		NS	228.9		NS	222.2	
	Hill	NS	NS	221.7	*	*	204.5	NS	NS	225.3	NS	NS	216.5
Pelvis width	H.P.	189.9			189.7			190.9			186.8		
	M.P.	NS	190.0		NS	176.4		NS	192.4		NS	190.0	
	Hill	NS	NS	191.0	NS	NS	177.6	NS	NS	189.3	NS	NS	179.1
Cannon length	H.P.	125.1			124.2			140.1			136.0		
	M.P.	NS	126.1		NS	122.4		NS	138.9		NS	137.2	
	Hill	NS	NS	126.2	NS	NS	122.5	NS	NS	138.1	NS	NS	135.7
Leg length	H.P.	360			344			399			383		
	M.P.	NS	362		NS	350		NS	390		NS	386	
	Hill	NS	NS	357	NS	NS	345	NS	NS	396	NS	NS	381
Tibia length	H.P.	189.4			185.3			212.9			204.7		
	M.P.	NS	190.3		NS	182.4		NS	211.5		NS	205.3	
	Hill	NS	NS	191.4	NS	NS	181.5	NS	NS	206.5	NS	NS	202.4

Born 1957

+ Number of animals in brackets.
*** = Significant at the 0.1% level of probability.
** = " " " 1% " " "
* = Significant at the 5% level of probability.
NS = Non-significant.

pelvis width were still significant. In the other measurements, although some of the differences were considerable, it was not possible to prove them significant. In the N.C.C. breed at 39 months there were still no significant differences between the treatments in any of the measurements in the heavy weight class in spite of increased differences in girth, body length and pelvis width. In the light weight class the significant differences present at 27 months in girth and pelvis length had disappeared, while the H.P. animals had become significantly greater in body length than those of the other two treatments and significantly smaller in pelvis width than the M.P. animals which were still significantly greater than the L.P. animals in this measurement.

Born 1957. Between 18 and 27 months the H.P. heavy sub-groups, S.C.C. and N.C.C. respectively, increased in size by a further 1.7% and 0.8%, compared with the H.P. light sub-groups which increased by 1.2% and 0.6%, making the former 17.2% and 17.6% and the latter 20.8% and 18.2% larger at 27 months than they were at 5 months. Only in the S.C.C. breed was there a very limited increase in most of the measurements in both weight classes, in the N.C.C. breed growth had virtually ceased. The only measurement to show considerable and consistent relative increase in both breeds and both weight classes was pelvis width. During this time the M.P. heavy sub-groups, S.C.C. and N.C.C. respectively, increased in size by a further 1.7% and 2.3%, compared with the M.P. light sub-groups, which increased by 1.7% and 1.9%, making the former 16.0% and 17.3% and the latter 15.8% and 19.0% larger at 27 months than they were at 5 months. In the S.C.C. heavy weight class all measurements except cannon length and leg length increased during this time, while in the S.C.C. light weight class all measurements except tibia length increased. In the N.C.C. heavy weight class all measurements except leg length increased, while in the N.C.C. light weight class girth decreased and all other measurements except pelvis length increased. Pelvis width showed the greatest relative increase in both weight classes in both breeds. The Hill heavy sub-groups, S.C.C. and N.C.C. respectively, increased in size by a further 4.2% and 5.0%, compared with the Hill light sub-groups, which increased by 3.4% and 2.8%, making the former 16.8% and 16.0% and the latter 15.6% and 16.1% larger at 27 months than they were at 5 months. Apart from girth in the N.C.C. light weight class, which remained unchanged, all measurements in both weight classes in both breeds increased during this time, with pelvis width showing very much greater relative increase than any of the other measurements.

In the S.C.C. breed at 27 months there were no significant differences present between the treatments in any of the measurements in the heavy weight class. In the light weight class, however, the Hill animals were still significantly smaller than both the H.P. and M.P. animals in pelvis length and the M.P. animals only in body length, while they had again become significantly smaller than both the H.P. and M.P. animals in girth. No other differences were significant, although in pelvis width they were still considerable. In the N.C.C. breed at 27 months the Hill animals in the heavy weight class were still significantly smaller in body length than both the H.P. and M.P. animals but no other differences were significant. In the light weight class there were no significant differences present between the treatments in any of the measurements, although in pelvis length and pelvis width some of the differences were still considerable.

4. Live measurement discussion.

(a) Treatment period, 6 - 12 months. In examining the effects of treatment on live measurement changes in the three years experiments there are several factors which must be considered while comparing results over the three years as illustrated in the histograms in Figs. V, Va and Vb. These are the age at which the treatments are applied, the degree of treatment and the length of time the treatments are imposed. It is perhaps also necessary to consider what effect environment during the first 6 months has had on physiological age as opposed to chronological age at the start of the treatment period.

In examining percentage gain over the treatment period it should therefore be remembered that the 1957 born age group were five weeks younger than the 1956 born age group at the start of the treatment period and as well as receiving treatment for five weeks longer, they also received more extreme treatments. The 1958 born age group started their treatments at an intermediate stage, being two weeks younger than the 1956 born age group. In addition to this they were born and reared in a severe season and were probably relatively retarded in growth and at a younger physiological age by 6 months compared with the previous two age groups. Finally, they received very much less extreme treatments than either of the other two age groups.

With these points in mind it becomes a little easier to interpret some of the differences in response of the measurements existing between the three years. Firstly, in all years, girth, being a measurement largely concerned with fat and flesh cover, was very closely related to the live weight changes in all treatment groups. The other three body measurements, body length, pelvis length and pelvis width, while affected by tissue cover to a certain extent, were all measurements of bone which was capable of responding at the time the treatments were applied. Pelvis width was probably the latest developing of these measurements as is shown by its greater increase in the H.P. groups than the others in the 1956 born age group. The potential for growth in the other two body measurements in this year was probably past its peak when the treatments were applied. The earlier start in 1957 appears to have benefited these measurements to a greater extent, in this year their response being almost as great as that of pelvis width, particularly pelvis length. Even on a M.P. diet the earlier start in 1957 has resulted in considerable gain in the two pelvis measurements in animals whose live weight was virtually only maintained, unlike 1956 where growth on a M.P. diet was fairly restricted. The responses in the 1958 born age group of body length and the two pelvis measurements illustrate the considerable effect of a very limited Away diet on animals which had been retarded during their first 6 months of life.

In the three leg measurements the responses are even more interesting. By the start of the 1956 treatment period the potential for length growth in the cannon was largely over and treatment had little effect on it. In 1957 and 1958 this was not the case, increase in length being considerable on both M.P. and Hill diets. The M.P. gain was as great if not greater and the Hill gain certainly greater, than that of the four body measurements. Leg length followed cannon length generally in its response, incorporating as it did the cannon bone, only in 1956 was the response unusual and here error in measuring technique may be the cause. Tibia length also followed cannon length in its response but appears to be later developing and to have greater porential for growth than the cannon during this time.

In general it can be said that the body measurements are capable of greater differential response to treatment than the leg measurements. Depending to some extent on the stage of development when treatment is applied, growth in length of the legs and the bones in them is obviously an essential component of development which will continue even on a sub-maintenance diet and results in only limited differences between treatment, compared with the considerable treatment differences possible in the body measurements. This agrees with the statement made by Fraser (1937) that a poor level of winter feeding results in a lean and lanky conformation, the animals so wintered being relatively long in the leg and narrow in the body at 12 months of age. From the results of this study it is apparent that the greatest effect of improved wintering is to widen the body as is shown by the greater increase in girth and pelvis width.

In order to describe the effects of treatment on overall changes in size of the experimental animals, the mean percentage gain of the seven measurements has been employed. This is shown in Table 38, over the treatment period the

Table 38

Mean percentage gain of seven live measurements from start of treatment period.

	S.C.C.			N.C.C.		
Born 1956						
27 weeks to	H.P.	M.P.	L.P.	H.P.	M.P.	L.P.
49 weeks	7.0	2.9	-1.2	7.2	1.8	-0.2
57 weeks	13.0	8.6	6.3	13.2	8.9	6.4
80 weeks	16.4	13.6	12.6	16.7	13.7	12.1
27 months	16.3	15.0	14.2	15.9	14.4	12.6
39 months	20.4	17.8	16.7	18.9	18.3	16.6
Born 1957						
22 weeks to	H.P.	M.P.	Hill	H.P.	M.P.	Hill
49 weeks	9.4	3.5	0.9	9.9	4.1	-0.1
57 weeks	11.3	7.9	5.7	11.4	8.8	4.4
79 weeks	17.0	14.2	12.6	17.5	16.1	12.3
27 months	18.8	16.2	16.2	18.0	18.2	16.0
Born 1958						
25 weeks to	Away	Hill		Away	Hill	
49 weeks	7.3	2.0		7.2	2.0	
68 weeks	16.2	14.4		17.6	15.0	
82 weeks	17.9	16.3		18.8	16.4	

1956 born H.P. and the 1958 born Away animals in both breeds gained 7%, while the M.P. and Hill animals in the same two age groups gained 2%. The earlier, longer and more extreme treatments in the 1957 born age group resulted in the H.P. animals gaining 9 - 10% and the M.P. animals 4%. The 1956 and 1957 born L.P. and Hill animals all virtually remained the same size.

When live measurement responses over the treatment period of the heavy and light animals in each treatment group are considered the following picture emerges. On a H.P. diet as in the first two years experimental age groups the light animals exhibited a greater increase in the body measurements relative to the leg measurements than was the case with the heavy animals. This was most striking in the S.C.C. breed, being slightly less obvious in the N.C.C. breed. There was little difference in the other treatment groups between the weight classes in the relative responses of both body and leg measurements. This, however, was purely relative, as in all treatment groups there was a tendency for the light animals to alter more than the heavy in the body measurements to a greater degree than they did in the leg measurements. This was more striking in the N.C.C. breed than in the S.C.C. breed.

It is apparent that the timing of treatment relative to the animals' physiological age has a considerable effect on the relative responses of the measurements in the two weight classes, particularly in the leg measurements. A L.P. diet, if applied early enough, or a Hill environment of early and average severity as in 1957, while stopping body growth in both weight classes, appears to retard leg growth in the heavy weight class more than in the light, although later application may not demonstrate this. It is obvious that there is insufficient known about the relative development of heavy and light animals at 6 months of age and while this study does point out some trends it is still extremely restricted without the knowledge of what creates the differences present at that time, it being possible to liken the first 6 months of life to a treatment period of unknown variability.

Expressing the changes in size over the treatment period as the mean percentage gain of the seven measurements as in Table 39, shows the 1956 and 1958 born H.P. and Away heavy animals in both breeds to have gained 6 - 7% while the light gained 7 - 8%. In the same two age groups the M.P. and Hill heavy animals gained 1 - 3% and the light animals 2 - 3%. The 1957 born H.P. heavy animals gained 8 - 9% and the light animals 10 - 11%, while both heavy and light M.P. animals gained roughly the same, namely 4%. The 1956 and 1957 L.P. and Hill heavy animals ranged from no change to a loss of 2% and the light animals from no change to a gain of 2%.

In general the treatments created significant differences at 49 weeks in practically all the measurements in the three experimental age groups. Only in leg length in the 1957 and 1958 born S.C.C. animals did the treatments fail to produce significance. Particularly in the three leg measurements there were some treatment differences that were not significant but they did not follow any definite trend and have been discussed previously in the appropriate sections. In the heavy and light animals it was in the two pelvis measurements that the treatments created the most consistent range of significant differences in both weight classes over the three years. In the other measurements there was considerable variation in the significance between sub-groups and very little relative difference between the two weight classes.

(b) Summer after treatment, 12 - 18 months. Having shown above how the response of the various live measurements to different wintering treatments is to some extent related to the stage of development or physiological age of the animals at the start of the treatment period, interest now lies in the response subsequent to wintering in an identical summer environment. Figs. VII, VIIa and VIIb indicate how seasonal effects are greater than treatment effects although there is apparently an interaction between season and the degree of development at 12 months which results in differences in response in any one treatment group in different years.

Table 39

Heavy and light hoggs prior to treatment. Mean percentage gain of seven live measurements from start of treatment period.

Born 1956

27 weeks to		S.C.C. H.P.	S.C.C. M.P.	S.C.C. L.P.	N.C.C. H.P.	N.C.C. M.P.	N.C.C. L.P.
49 weeks	Heavy	6.1	3.0	-1.5	6.8	1.2	-0.6
	Light	8.4	3.1	-0.4	7.2	2.4	0.2
57 weeks	Heavy	11.3	8.9	5.2	12.2	7.1	7.0
	Light	15.5	9.5	7.9	13.3	10.1	5.8
80 weeks	Heavy	14.8	12.7	11.3	15.7	12.2	13.0
	Light	19.1	15.2	14.6	16.8	14.9	11.4
27 months	Heavy	14.4	15.5	13.3	14.7	13.8	13.6
	Light	17.9	16.0	15.7	16.3	15.5	10.9
39 months	Heavy	18.6	18.7	16.2	18.9	17.7	17.5
	Light	21.7	18.8	17.4	18.6	19.3	15.1

Born 1957

22 weeks to		S.C.C. H.P.	S.C.C. M.P.	S.C.C. Hill	N.C.C. H.P.	N.C.C. M.P.	N.C.C. Hill
49 weeks	Heavy	7.9	3.9	0.1	8.7	3.9	-0.5
	Light	10.3	3.4	1.9	10.8	4.6	0.3
57 weeks	Heavy	9.9	8.3	5.6	10.2	8.3	3.7
	Light	13.5	7.6	4.8	12.2	9.2	5.3
79 weeks	Heavy	15.5	14.3	12.6	16.8	15.0	11.0
	Light	19.6	14.1	12.2	17.6	17.1	13.3
27 months	Heavy	17.2	16.0	16.8	17.6	17.3	16.0
	Light	20.8	15.8	15.6	18.2	19.0	16.1

Born 1958

25 weeks to		S.C.C. Away	S.C.C. Hill	N.C.C. Away	N.C.C. Hill
49 weeks	Heavy	7.2	1.8	6.2	1.3
	Light	7.2	2.1	8.4	2.7
68 weeks	Heavy	15.7	13.5	16.0	13.0
	Light	17.6	15.4	19.9	16.4
82 weeks	Heavy	17.6	15.2	16.9	14.1
	Light	18.7	17.1	21.6	18.1

Over the first eight weeks of the summer after treatment growth as described by the seven measurements was very different in the first two experimental years. In the 1956 born age group the H.P. animals in both breeds increased in size almost as much during this time as they had during the treatment period and very little less than the L.P. animals, with the M.P. animals being similar to the H.P. in the S.C.C. breed and to the L.P. in the N.C.C. breed. In the 1957 born age group, however, the H.P. animals increased very little during this time and very much less than both the M.P. and Hill animals which were very similar in response. Environmental conditions at the time undoubtedly had a considerable effect on the relative differences between these years but only in the 1957 born H.P. animals, which had received a very high standard of rearing, did the severe spring of 1958 produce any very great retardation of growth and even here loss of condition with its resultant reduction in girth disguises a certain degree of skeletal growth.

It is not possible to compare the 1958 born age group with the previous two at this time on account of the former's later date of recording. However the Hill animals in both breeds increased relatively more than the Away over the first half of the summer, which generally agrees with the trends occurring in the 1956 and 1957 born age groups.

In all three age groups during the earlier part of the summer the greatest relative increase was shown in pelvis width regardless of treatment, while excluding girth, which by being closely related to the condition of the animal was frequently the most retarded, the least relative increase was normally shown by one of the three leg measurements. In general, particularly in the 1957 and 1958 born age groups, the four body measurements gained relatively more than the three leg measurements during this time regardless of treatment.

Over the last 22 - 23 weeks of the summer period in the 1956 and 1957 born age groups, the H.P. animals in both breeds increased in size to a lesser degree than the L.P. or Hill animals with the M.P. animals being intermediate. Also the 1956 born animals increased to a lesser extent in all treatment groups than the 1957 born. Again excluding girth, the greatest relative increase in all three age groups during the latter part of the summer was shown by pelvis width regardless of treatment, while the least relative increase was shown by one of the three leg measurements, in most cases cannon length, indicating the early developing nature of this bone, by 18 months length growth having virtually ceased. In the first two age groups, increase in the four body measurements was relatively greater than that of the three leg measurements even more so during this time than during the early part of the summer.

Over the whole summer period the greatest relative increase in size was shown by the L.P. or Hill animals, with the next greatest by the M.P. animals and the least by the H.P. or Away animals, within any one year. However, in spite of these differences, the H.P. animals in both breeds born 1956 and 1957 were (see Table 38) 16 - 17% larger at 18 months than they were prior to treatment while the L.P. and Hill animals were only 12 - 13% larger, with the M.P. animals being 14% larger, apart from the 1957 born N.C.C. M.P. group which was 16% larger, similar to the H.P. animals. The 1958 born Away animals were 18 - 19% larger while the Hill animals were 16% larger, both these groups gaining relatively more on account of their smaller size initially at 6 months.

When the relative response of the two weight classes in each treatment group is considered over the early part of the summer the general picture in the heavy weight class is one of greater relative increase by the L.P. or Hill animals than the H.P. or Away animals with the M.P. animals varying considerably according to their relative positions as previously described by live weight. In the light weight class the picture is not so clear cut, with the 1956 born N.C.C. L.P. and the 1957 born S.C.C. Hill animals showing smaller relative gains than those of the other treatments although in all other cases the heavy weight situation was repeated. An explanation for the above exceptions is difficult to find but they may be due to these animals being so retarded in early life that they are beyond the point of recovery by 12 months of age.

Over the latter part of the summer these differences had disappeared and in both weight classes the relative increases were greater in every case in the L.P. or Hill sub-groups than in the H.P. or Away, with the M.P. sub-groups showing relative gains very little less than those of the L.P. or Hill.

During the early part of the summer the light animals in all treatment groups generally showed greater relative gains than the heavy but in the latter part of the summer, while this was still the case in the M.P., L.P. and Hill groups, in the H.P. and Away groups there was tendency for both weight classes to show similar relative gains.

Over the whole summer period, however, the greatest relative increase was shown by the L.P. or Hill animals in both weight classes, with the next greatest by the M.P. animals and the least by the H.P. or Away animals. In spite of this, at 18 months (see Table 39) the L.P. and Hill heavy animals born 1956 and 1957 were still only 11 - 13% larger than they were prior to treatment compared with the H.P. heavy animals which were 15 - 17% larger and the M.P. heavy animals which covered a greater range and were from 12 - 15% larger. In the light weight class the L.P. and Hill animals were still only 11 - 14% larger than they were prior to treatment compared with the H.P. and M.P. animals which were 17 - 19% and 14 - 17% larger respectively. In the 1958 born heavy weight class, the Hill and Away animals were 14 - 15% and 17% larger respectively at 18 months while in the light weight class the Hill and Away animals were 17 - 18% and 19 - 21% larger respectively. In general at 57 weeks in the first two age groups significant differences were still present between all the treatments in both breeds in the four body measurements with one or two minor exceptions in girth and body length between the M.P. groups and the H.P., L.P. or Hill groups, due to the varied response of the M.P. groups. In the three leg measurements, however, while there were still some significant differences present, the general trend was for significance to disappear, particularly between the H.P.

and M.P. groups in both breeds, indicating the limited retardation of growth in these measurements in animals wintered on a M.P. or maintenance diet. To a lesser extent the significance of differences in the leg measurements between the M.P. and L.P. or Hill groups also tended to disappear, indicating overall the very short term effect of treatment on leg growth. In the body measurements, pelvis width and pelvis length showed the greatest differences between treatments at this time, while in the leg measurements, cannon length and leg length showed the least, with the tibia, being a later developing bone than the cannon, showing its greater response to treatment by the presence of significant differences in more cases than the other two measurements, particularly in the N.C.C. breed and particularly in the 1956 born age group.

In the 1958 born age group at 68 weeks the same general trends were still apparent with significant differences existing between the treatments in the body measurements, particularly in the N.C.C. breed, while the only significantly different leg measurement was the N.C.C. tibia length.

At 18 months in the first two age groups, significant differences were still present in the four body measurements between the H.P. and L.P. or Hill groups. Between these groups and the M.P. groups, however, significance was tending to disappear at this time in several of the measurements, only in pelvis length were the differences anything near consistently significant. In the three leg measurements, differences in cannon length were no longer significant and in only one case was there a significant difference in leg length. In tibia length, however, some of the treatment differences were still significant, particularly in the 1956 born age group and particularly in the N.C.C. breed.

In the 1958 born age group at 18 months there was little difference between the treatments in any of the measurements with significance still present only in two different body measurements in each of the breeds and appearing for the first time in the N.C.C. leg length.

At 57 weeks in the first two age groups significant differences were still present in both weight classes between the H.P. and L.P. or Hill animals in both breeds in the four body measurements with the exception of body length in three out of the eight cases. In the three leg measurements, however, significance was tending to disappear in the light animals to a greater extent than in the heavy, suggesting that the treatments have had a greater effect on the latter. Between the H.P. and M.P. animals, significant differences had practically disappeared in the heavy weight class, while they were still present in the four body measurements in the light weight class. This suggests that contrary to the above situation in the leg measurements, the treatments have had a greater effect on the light animals than on the heavy in the body measurements. Between the M.P. and L.P. or Hill animals, significant differences were present to approximately the same extent in both weight classes in the four body measurements but had virtually disappeared in the light weight class in the three leg measurements, while in the heavy weight class there was still a degree of significance.

In the body measurements the differences between treatments were very similar at this time in both weight classes in body length and pelvis width but in girth and pelvis length the differences were greater in the light weight class than they were in the heavy. In the leg measurements the differences were very similar in both weight classes in cannon length and tibia length but in leg length the differences were very much greater in the heavy weight class.

In the 1958 born age group at 68 weeks it was in the heavy animals in both breeds that significant differences were still present to a limited extent, more so in the body than in the leg measurements. The only significant difference in the light weight class was in the N.C.C. pelvis length.

At 18 months in the first two age groups significant differences were still present between the H.P. and L.P. or Hill animals in both breeds in the four body measurements to a greater extent in the light weight class than in the heavy, particularly in the pelvis measurements. In the three leg measurements the only significant differences still present were in the N.C.C. tibia length in one case out of two in each weight class. Between the H.P. and M.P. animals significance had virtually disappeared in the heavy weight class in all measurements but was still present to a limited extent in the light weight class, particularly in the S.C.C. breed and in the pelvis measurements. None of the leg measurements were significantly different in either weight class. Between the M.P. and L.P. or Hill animals significance had virtually disappeared in the heavy weight class but was still present to a limited extent in the light weight class, again particularly in the pelvis measurements, while there was one case of significance in tibia length in the N.C.C. light weight class. In the body measurements the differences between treatments were much greater at this time in the light weight class in body length and the two pelvis measurements than they were in the heavy weight class. There was little difference between treatments in the leg measurements in either weight class.

In the 1958 born age group at 18 months there were virtually no significant differences still present and no distinct trends in either weight class.

(c) <u>From 18 months onwards</u>. Between 18 and 27 months in the first two age groups, a period which covered their second winter of life and their first pregnancy and lactation, very little growth in size as described by the seven measurements occurred in any of the treatment groups in either breed. With the competition for available nutrients introduced by lamb production at a time when the nutrients are in short supply and live weight has decreased it is to be expected that animals at such a late stage in their growth and development will show practically no growth. This was particularly so in the H.P. groups in both breeds and both years, with season having a very strong influence on these groups, as shown by the differences in response between the 1956 and 1957 born animals. The 1956 born animals in their second winter, which was that of 1957-58, were subjected to a very much severer environment than the 1957 born animals were in the winter of 1958-59, a very open winter. This caused the former to decrease in girth considerably and to show no increase in the other measurements apart from pelvis width, which continued to increase during this time. In the 1957 born H.P. animals, however, the open winter, while virtually maintaining girth, also permitted a limited increase to occur in most of the other measurements.

The 1956 born M.P. animals, although decreasing in girth, similar to the H.P. animals, did, however, increase in the other three body measurements but not in the leg measurements, while the 1957 born M.P. animals showed a similar picture to that of the 1957 born H.P. animals above. The 1956 born L.P. animals showed a very similar picture to that of their corresponding M.P. animals above but the 1957 born Hill animals showed very much greater increases in all measurements than their corresponding H.P. and M.P. animals during this time, with pelvis width in particular showing relatively very much more. This further emphasises the effect of season on growth subsequent to treatment, the winter of 1958 maintaining the relative differences between the 1956 born treatments to a greater extent than was the case with the 1957 born treatments in the more open winter of 1959, particularly in the N.C.C. breed.

In general, the leg measurements showed the least relative responses in all treatment groups in both breeds between 18 and 27 months, their potential for length growth being virtually over, while in the body measurements, pelvis width showed the greatest and most consistent relative increase regardless of treatment or season.

In spite of the limited but continued increase in size shown by the M.P. , L.P. and Hill animals during this time, compared with the cessation of growth shown by the H.P. animals, which reduced the differences between the treatments in mean size, there were still recognisable differences at 27 months. From Table 38 it can be seen that while the two H.P. groups born 1956 were approximately 16% larger at this time than they were prior to treatment, the M.P.

groups were only 14 - 15% and the L.P. groups still only 13 - 14% larger. In the 1957 born age group, however, the two H.P. groups and the N.C.C. M.P. group were 18 - 19% larger, while the two Hill groups and the S.C.C. M.P. group were only 16% larger.

When the growth and development of the two weight classes in each treatment group is considered from 18 - 27 months, the most striking difference is the apparently greater relative mean increase of the heavy animals than the light animals in all treatment groups. This was very largely due to either a greater increase or a smaller decrease in girth in the former than was the case in the latter but there was also a tendency for certain of the other measurements to increase relatively more in the heavy than the light animals. This tended to be least obvious in the H.P. groups, being more obvious in the M.P. groups and most striking in the L.P. and Hill groups, resulting in a greater reduction in the differences between treatments in the heavy weight class than in the light weight class. This provides further evidence to support the suggestion arising from the live weight results that the heavier animals at 6 months of age have a greater potential for growth than the light animals which are probably more permanently affected by treatment during their first winter.

Table 39 illustrates this point, in the 1956 born heavy animals in both breeds the mean percentage live measurement gains from the start of the treatment period to 27 months in all three treatments only ranged from 13 - 15% and in the 1957 born heavy animals the picture was similar, with the gains only ranging from 16 - 18%. In the 1956 born light animals, however, the H.P. gains were 16 - 18%, the M.P. gains 15 - 16% and the L.P. gains only 11 - 16%, while in the 1957 born light animals the H.P. gains were 18 - 21%, the M.P. gains 16 - 19% and the Hill gains only 15 - 16%.

In the S.C.C. breed at 27 months, there were no significant differences in any of the measurements between the treatment means in either year, although those differences that did remain, notably in the body measurements, were generally in favour of the better rearing treatments. In the two weight classes, however, while there were no significant differences between the treatment means in the heavy weight class in either year nor in the 1956 born light weight class, there were still significant differences in the 1957 born light weight class in girth, body length and pelvis length, mainly due to the much smaller size of the Hill light animals.

In the N.C.C. breed at 27 months, the only measurement in which significant differences were still present between the treatment means in both years was body length, while there were also significant differences still present in tibia length in the 1956 born age group. In tibia length in the other age group and in the two pelvis measurements in both years, there were differences in favour of the better rearing treatments which, although not significant, were still considerable. In the two weight classes, however, only in the 1957 born heavy animals were the differences in body length still significant, this being the only measurement to show significance in the heavy weight class in either year. In the light weight class there were no significant differences between the treatment means in any measurements in the 1957 born age group but in the 1956 born age group there were still significant differences in girth, pelvis length and pelvis width, mainly due to the much smaller size of the L.P. light animals.

Over the year from 27 - 39 months in the 1956 born age group, growth continued in all treatment groups, particularly in the body measurements, having practically ceased in the leg measurements. In the S.C.C. breed the H.P. animals responded to a greater extent than the M.P. and L.P. animals, unlike the N.C.C. breed where the M.P. and L.P. animals responded more than the H.P. animals. Pelvis width still continued to increase considerably during this time in all treatment groups and relatively more than any of the other measurements excluding girth, which continued to fluctuate with changes in body weight. As a result of these changes, by 39 months (Table 38) the H.P. animals in both breeds were 19 - 20% larger than they were prior to treatment, the M.P. animals 18% larger and the L.P. animals 16 - 17% larger.

When the two weight classes are considered during this time the light animals in all treatment groups in the S.C.C. breed and in the H.P. group in the N.C.C. breed showed smaller relative gains than the heavy animals, largely due to smaller increases in girth. This was not the case in the N.C.C. M.P. and L.P. groups, where the increase was relatively as great in the light animals as it was in the heavy, making the M.P. light animals the largest in their weight class and overcoming the retarded growth in the L.P. light animals which was apparent at 27 months. With the exception of the N.C.C. light animals, the overall effect was for the differences in size between the treatment sub-groups to increase between 27 and 39 months in both weight classes. In both breeds the differences were greater in the light weight class than in the heavy weight class. Table 39 shows the H.P. and M.P. heavy animals in both breeds to be 18 - 19% larger at 39 months than they were prior to treatment and the L.P. heavy animals to be 16 - 18% larger, while the H.P. and M.P. light animals were 18 - 22% larger and the L.P. light animals only 15 - 17% larger.

In the S.C.C. breed at 39 months, the greater relative response of the H.P. and M.P. animals resulted in the reappearance of significant differences between the total treatment means in pelvis length and tibia length but this was not apparent in either weight class. In the N.C.C. breed at 39 months, a significant difference was still present in body length but significance had disappeared from the differences in tibia length. In the heavy weight class there were no significant differences between the treatment means in any of the measurements at this time but in the light weight class there were still significant differences in pelvis width and significance had reappeared in body length.

IV. Dissection data

1. Introduction. With only sample animals being selected for dissection prior to treatment, post treatment and at 18 months, it was necessary to select individuals which were as typical of the groups as possible at each time. Details of live weight and live measurements of the animals selected from the 1956 and 1957 born age groups are shown respectively in Appendices IV and V, along with the breed and group means on which selection was based. The animals selected were photographed against a 10 cm. squared board and are shown in Plates 7, 8, 9, 10, 11 and 12. Details of age at slaughter, unfasted and fasted live weights and hot and cold carcass weights are shown in Appendices VI and VII. The actual weights of muscle, fat, bone and tendon dissected from the hindquarter joints of each individual are shown in Appendices VIII and IX.

In the discussion that follows the growth and development of the various body parts, organs, joints and tissues has been compared between the treatments at 12 and 18 months. With only one individual being dissected from each treatment group in each breed in each year, no statistical analysis has been carried out and it is obvious that both error in selection and individual variation may introduce variations in results when compared with other individuals. In addition, growth and development over the treatment period and from prior to treatment to 18 months has been studied in each treatment by relating the 12 and 18 month records in each case to the mean of the two individuals dissected prior to treatment in each breed and each year. Error in selection and individual variation again may produce results of doubtful validity. Therefore, in the discussion, only trends which are persistent and uniform in both breeds and both years have been commented on with any degree of confidence. Where there appears to be a distinct breed or year difference this has been referred to but unless otherwise stated the following discussion refers to both breeds and both years. In many cases a mean figure has been quoted for the four individuals at any one time of recording where clarification warrants it. In view of these limitations it is stressed that interpretation of the results must not be considered conclusive but are merely trends which the writer suggests may occur.

2. Slaughter weights of body parts, organs and their accompanying tissues. The weights, both actual and as percentages of fasted live weight, of dressed carcass, skin + wool, head, feet, digestive system (full) and fluids, other organs and loss of the dissected animals at the three ages in both years are shown in Tables 40 and 40a. The five weeks earlier slaughtering pre-treatment in 1957 resulted in a lower dressed carcass percentage, being only 48% compared with 51% pre-treatment in 1956. This was balanced by the digestive system being 3% greater in 1957 than in 1956. All other organs and tissues were constant in their proportions at both times.

At 12 months, post-treatment, dressed carcass percentage was much higher in the H.P. animals and fairly constant, averaging 49%, with the M.P. animals, also fairly constant, averaging 43%. In every case the digestive system was inversely proportional to the dressed carcass percentage. The L.P. animals, artificially wintered inside, had however, much lower dressed carcass percentages than the naturally wintered Hill animals, namely 40% compared with 46%. This was largely due to the very much lighter digestive systems possessed by the latter, which averaged only 22% of the total live weight compared with 30% in the L.P. animals. This demonstrates the development of a much larger digestive system in sheep wintered on an artificial L.P. diet of high fibre content than occurs in sheep wintered unsupplemented on the hill. A further point of interest in digestive system development is the actual as well as proportionally lighter systems possessed by the H.P. animals born 1956, than possessed by both the M.P. and L.P. animals, with the latter possessing the heaviest. This was repeated in the N.C.C. H.P. and M.P. animals born 1957 but not in the S.C.C. animals, while the Hill animals, as discussed above,

Table 40

Actual and percentage weights at slaughter of animals born 1956. (Weights in gms.)

S.C.C.

Age			Live wt. fasted	Dressed carcass	Skin + wool	Head	Feet	Digestive system	Fluids, other organs and loss
29 weeks	Pre-treatment*	Wt.	24494	12587	2631	1202	544	4604	2926
		% of live wt.	100	51.4	10.7	4.9	2.2	18.8	11.9
	H.P.	Wt.	34474	17237	3667	1771	772	6265	4762
		% of live wt.	100	50.0	10.6	5.1	2.2	18.2	13.8
50 weeks	M.P.	Wt.	29484	12928	3223	1498	726	7173	3936
		% of live wt.	100	43.8	10.9	5.1	2.5	24.3	13.3
	L.P.	Wt.	25855	10206	2906	1317	545	8081	2800
		% of live wt.	100	39.5	11.2	5.1	2.1	31.3	10.8
	H.P.	Wt.	42638	21546	4449	2088	863	6719	6973
		% of live wt.	100	50.5	10.4	4.9	2.0	15.8	16.4
81 weeks	M.P.	Wt.	40370	19278	3632	1816	726	6855	8063
		% of live wt.	100	47.8	9.0	4.5	1.8	17.0	20.0
	L.P.	Wt.	38556	17010	4631	1680	772	7627	6836
		% of live wt.	100	44.1	12.0	4.4	2.0	19.8	17.7

* Mean of two animals.

Table 40 (contd.)

Actual and percentage weights at slaughter of animals born 1956. (Weights in gms.)

N.C.C.

Age			Live wt. fasted	Dressed carcass	Skin + wool	Head	Feet	Digestive system	Fluids, other organs and loss
29 weeks	Pre-treatment*	Wt.	27216	13948	2835	1247	635	4899	3652
		% of live wt.	100	51.2	10.4	4.6	2.3	18.0	13.4
50 weeks	H.P.	Wt.	37195	17690	5039	1816	772	7627	4251
		% of live wt.	100	47.6	13.5	4.9	2.1	20.5	11.4
	M.P.	Wt.	34020	14969	4268	1680	772	8989	3342
		% of live wt.	100	44.0	12.5	4.9	2.3	26.4	9.8
	L.P.	Wt.	28577	11794	3450	1544	681	8308	2800
		% of live wt.	100	41.3	12.1	5.4	2.4	29.1	9.8
81 weeks	H.P.	Wt.	48535	24948	4313	2088	863	8626	7697
		% of live wt.	100	51.4	8.9	4.3	1.8	17.8	15.9
	M.P.	Wt.	45360	22000	4268	2134	772	8853	7333
		% of live wt.	100	48.5	9.4	4.7	1.7	19.5	16.2
	L.P.	Wt.	40824	19505	3814	1952	817	6946	7790
		% of live wt.	100	47.8	9.3	4.8	2.0	17.0	19.1

* Mean of two animals.

Table 40a

Actual and percentage weights at slaughter of animals born 1957. (Weights in gms.)

S.C.C.

Age			Live wt. fasted	Dressed carcass	Skin + wool	Head	Feet	Digestive system	Fluids, other organs and loss
24 weeks	Pre-treatment*	Wt.	25855	12361	2769	1226	477	5584	3438
		% of live wt.	100	47.8	10.7	4.7	1.8	21.6	13.4
50 weeks	H.P.	Wt.	37649	17350	4858	1680	681	9080	4000
		% of live wt.	100	46.1	12.9	4.5	1.8	24.1	10.6
	M.P.	Wt.	28123	12247	2860	1544	590	8081	2801
		% of live wt.	100	43.5	10.2	5.5	2.1	28.7	10.0
	Hill	Wt.	23134	10433	2679	1407	590	5266	2759
		% of live wt.	100	45.1	11.6	6.1	2.5	22.8	11.9
80 weeks	H.P.	Wt.	41278	20639	3995	1907	681	9080	4976
		% of live wt.	100	50.0	9.7	4.6	1.6	22.0	12.1
	M.P.	Wt.	35834	18598	3178	1680	681	6810	4887
		% of live wt.	100	51.9	8.9	4.7	1.9	19.0	13.6
	Hill	Wt.	36288	17237	3360	1725	772	8853	4341
		% of live wt.	100	47.5	9.3	4.7	2.1	24.4	12.0

* Mean of two animals.

Table 40a (contd.)

Actual and percentage weights at slaughter of animals born 1957. (Weights in gms.)

Age			Live wt. fasted	N.C.C. Dressed carcass	Skin + wool	Head	Feet	Digestive system	Fluids, other organs and loss
24 weeks	Pre-treatment*	Wt.	28123	13608	2815	1362	681	5857	3800
		% of live wt.	100	48.4	10.0	4.8	2.4	20.8	13.6
50 weeks	H.P.	Wt.	39917	20525	4585	1771	863	7718	4455
		% of live wt.	100	51.4	11.5	4.4	2.2	19.3	11.2
	M.P.	Wt.	30845	12701	3995	1634	726	8762	3027
		% of live wt.	100	41.2	13.0	5.2	2.4	28.4	9.8
	Hill	Wt.	22680	10433	3042	1453	590	4676	2486
		% of live wt.	100	46.0	13.4	6.4	2.6	20.6	11.0
80 weeks	H.P.	Wt.	45814	23134	3859	2043	772	9080	6926
		% of live wt.	100	50.5	8.4	4.5	1.7	19.8	15.1
	M.P.	Wt.	43999	21319	4903	1861	817	9534	5565
		% of live wt.	100	48.5	11.1	4.2	1.9	21.7	12.6
	Hill	Wt.	39463	19051	4086	1816	726	8399	5385
		% of live wt.	100	48.3	10.4	4.6	1.8	21.3	13.6

* Mean of two animals.

possessed very much the lightest systems. Even the larger diets fed to the H.P. animals appear to have failed to produce digestive systems as large as those which animals in the other treatment groups have developed on diets of smaller quantity but greater fibre content. This suggests that the growing sheep, when fed a poor quality, high fibre diet, attempts to extract the maximum value from it by developing a larger digestive system and as a result is probably a much more efficient converter of the available nutrients than one which is adequately fed. This would account for the great difficulty met in getting the 1956 born L.P. animals to lose weight sufficiently on what was considered to be a starvation diet.

There were no consistent treatment differences in the proportions of skin + wool, feet or fluids, etc. but in general the head was proportionally heavier in the poorer treatments, indicating the very limited effect of treatment on one of the earliest developing and most important parts of the body.

At 18 months, dressed carcass percentage was still higher in the H.P. animals, averaging 51%, while the M.P. and L.P./Hill animals averaged 49% and 47% respectively, being fairly constant within each treatment. There were no consistent treatment differences at this time in the proportions of skin + wool, feet, digestive system or fluids, etc. but there was nevertheless a slight tendency for the L.P./Hill animals to average proportionally heavier digestive systems. Generally, at 18 months there was little difference between the selected animals from the three treatments in the proportions of body parts at slaughter.

In the above comparative study some of the effects of treatment are obscured by the proportion of one part affecting the proportion of another. To clarify this situation, in Tables 41 and 41a, the weight of each body part at 12 and 18 months is shown in the H.P. and M.P. animals as a percentage of the weight of the same body part in the L.P./Hill animals and in all three treatment animals at each age the weight is shown as a percentage of the weight

Table 41

Weights at slaughter of animals born 1956. H.P. and M.P. expressed as a percentage of L.P. and 50 and 81 weeks as a percentage of 29 weeks.

S.C.C.

Age	Treatment		Live wt. fasted	Dressed carcass	Skin + wool	Head	Feet	Digestive system	Fluids, other organs and loss
50 weeks	(% of L.P.	(H.P.	133	169	126	134	142	78	170
		(M.P.	114	127	111	114	133	89	141
	(% of 29 week weight	(H.P.	141	137	139	147	142	136	163
		(M.P.	120	103	122	125	133	156	135
		(L.P.	106	81	110	110	100	176	96
81 weeks	(% of L.P.	(H.P.	111	127	96	124	112	88	102
		(M.P.	105	113	78	108	94	90	118
	(% of 29 week weight	(H.P.	174	171	169	174	159	146	238
		(M.P.	165	153	138	151	133	149	276
		(L.P.	157	135	176	140	142	166	234

N.C.C.

Age	Treatment		Live wt. fasted	Dressed carcass	Skin + wool	Head	Feet	Digestive system	Fluids, other organs and loss
50 weeks	(% of L.P.	(H.P.	130	150	146	118	113	92	152
		(M.P.	119	127	124	109	113	108	119
	(% of 29 week weight	(H.P.	137	127	178	146	122	156	116
		(M.P.	125	107	151	135	122	183	92
		(L.P.	105	85	122	124	108	170	77
81 weeks	(% of L.P.	(H.P.	119	128	113	107	106	124	99
		(M.P.	111	113	112	109	94	127	94
	(% of 29 week weight	(H.P.	178	179	152	167	136	176	211
		(M.P.	167	158	151	171	122	181	201
		(L.P.	150	140	135	157	129	142	213

Table 41a

Weights at slaughter of animals born 1957. H.P. and M.P. expressed as a percentage of Hill and 50 and 80 weeks as a percentage of 24 weeks.

S.C.C.

Age		Treatment	Live wt. fasted	Dressed carcass	Skin + wool	Head	Feet	Digestive system	Fluids, other organs and loss
50 weeks	% of Hill	H.P.	163	166	181	119	115	172	145
		M.P.	122	117	107	110	100	153	102
	% of 24 week weight	H.P.	146	140	175	137	143	163	116
		M.P.	109	99	103	126	124	145	81
		Hill	89	84	97	115	124	94	80
80 weeks	% of Hill	H.P.	114	120	119	111	88	103	115
		M.P.	99	108	95	97	88	77	113
	% of 24 week weight	H.P.	160	167	144	156	143	163	145
		M.P.	139	150	115	137	143	122	142
		Hill	140	139	121	141	162	159	126

N.C.C.

Age		Treatment	Live wt. fasted	Dressed carcass	Skin + wool	Head	Feet	Digestive system	Fluids, other organs and loss
50 weeks	% of Hill	H.P.	176	197	151	122	146	165	179
		M.P.	136	122	131	112	123	187	122
	% of 24 week weight	H.P.	142	151	163	130	127	132	117
		M.P.	110	93	142	120	107	150	80
		Hill	81	77	108	107	87	80	65
80 weeks	% of Hill	H.P.	116	121	94	113	106	108	129
		M.P.	111	112	120	102	113	114	103
	% of 24 week weight	H.P.	163	170	137	150	113	155	182
		M.P.	156	157	174	137	120	163	146
		Hill	140	140	145	133	107	143	142

of the same body part prior to treatment.

These Tables show that after treatment at 12 months the greatest difference between the H.P. and L.P./Hill treatments was created in dressed carcass, followed by fasted live weight and skin + wool, with the least difference in head and feet, both being early maturing parts. The differences in digestive system have been discussed above and it is not intended to elaborate on them further. Fluids, other organs and loss are also being excluded from comparative discussion at this point as the various organs are individually discussed later. Between the M.P. and L.P./Hill treatments the differences varied very little in the various body parts, fasted live weight and dressed carcass showing slightly the greatest differences and head and feet the least.

Over the treatment period in the H.P. animals the part which showed the greatest increase was skin + wool and while there was little difference between the other parts, the feet showed the smallest increase. There was, however, a breed difference apparent here, the weight of the feet increasing by twice as much in the S.C.C. animals as they did in the N.C.C. animals, probably due to earlier and greater development prior to treatment in the longer legged latter breed. In the M.P. animals the greatest increase was shown by the digestive system, while dressed carcass remained unchanged. The smallest increase was shown by fasted live weight, with the other parts all increasing by a larger but approximately similar amount. In the L.P./Hill animals the picture was very similar, with the greatest increase shown by the digestive system and the greatest decrease by dressed carcass, followed by fasted live weight. Of the other parts, which all increased and differed only slightly, the greatest increase was by the head.

At 18 months the differences between treatments had decreased considerably. Between the H.P. and L.P./Hill animals the greatest difference was still in dressed carcass, followed by fasted live weight and head, with the other parts showing only small and very similar differences, the smallest being in the feet.

Between the M.P. and L.P./Hill animals the picture was similar but on a smaller scale, with the greatest differences still in dressed carcass and fasted live weight and virtually no differences in the other parts. There was actually a considerable breed difference apparent here, with the N.C.C. M.P. animals approaching the H.P. in response and the S.C.C. animals approaching the L.P./Hill, following the trends experienced by these total groups in live weight at this time.

From prior to treatment to 18 months in the H.P. animals the greatest increase was shown by dressed carcass, followed by fasted live weight, while the least increase was shown by the feet. Skin + wool is hardly comparable on account of the clipping that has taken place during this time. The head and digestive system showed similar increases in this treatment. The feet appear to have increased very little from 12 - 18 months, suggesting that on a H.P. diet they have nearly reached maturity by 12 months of age, containing as they do the cannon bone, one of the earliest maturing bones in the body. In the M.P. animals the smallest increase was again shown by the feet, while the rest of the parts showed very similar increases. Here also the feet appear to have gained very little between 12 and 18 months but more so than in the H.P. animals, while the digestive system had also apparently stopped increasing by 12 months. This was probably due to the greater development of this system in the M.P. animals over the treatment period than was the case in the H.P. animals. In the L.P./Hill animals there was very little difference between any of the parts in relative increase during this time, with the feet just showing slightly less than the others. All parts gained between 12 and 18 months after this treatment.

The actual weights of the organs and tissues grouped in Tables 41 and 41a under the heading of fluids, other organs and loss are shown individually in Tables 42 and 42a, along with the weights of the brain, eyes, kidneys and kidney fat at each of the three ages. Also shown is the weight of each organ

Table 42

Actual weights of organs and their accompanying tissues from animals born 1956 and slaughtered for dissection; with H.P. and M.P. expressed as a percentage of L.P. and 50 and 81 weeks as a percentage of 29 weeks. (Weights in gms.)

S.C.C.

Age	Treatment		Heart	Heart fat	Lungs + trachea	Liver	Spleen + diaphragm	Omentum	Brain	Eyes	Uterus	Kidneys(2)	Kidney fat
29 weeks	Pre-treatment+		105	74	374	365	136	250	88.8	19.1	15.7	72.5	377
	Wt.	H.P.	153	38	879	557	93	347	90.7	27.3	34.8	110.0	295
		M.P.	124	34	647	380	55	110	87.0	26.2	26.0	87.0	170
		L.P.	93	15	427	285	34	28	89.1	24.0	29.3	64.5	68
50 weeks	% of L.P.	H.P.	165	253	206	195	274	1226	102	114	119	171	434
		M.P.	133	227	152	133	162	389	98	109	89	135	249
	% of 29 week weight	H.P.	146	51	235	153	68	139	102	143	222	152	78
		M.P.	118	46	173	104	40	44	98	137	166	120	45
		L.P.	89	20	114	78	25	11	100	126	187	89	18
	Wt.	H.P.	191	30	833	633	113	733	107.0	31.0	40.0*	101.2	670
		M.P.	180	47	850	635	122	774	95.0	31.0	42.0*	98.0	605
		L.P.	174	51	764	599	115	307	91.0	29.4	33.2*	108.0	287
81 weeks	% of L.P.	H.P.	110	59	109	106	98	239	118	105	120	94	234
		M.P.	103	92	111	106	106	252	104	105	126	91	211
	% of 29 week weight	H.P.	182	41	223	173	83	293	120	162	255	140	178
		M.P.	171	64	227	174	90	310	107	162	268	135	160
		L.P.	166	69	204	164	85	123	102	154	211	149	76

+ Mean of two animals.   * Uterus less vagina.

Table 42 (contd.)

Actual weights of organs and their accompanying tissues from animals born 1956 and slaughtered for dissection; with H.P. and M.P. expressed as a percentage of L.P. and 50 and 81 weeks as a percentage of 29 weeks. (Weights in gms.)

N.C.C.

Age	Treatment		Heart	Heart fat	Lungs + trachea	Liver	Spleen + diaphragm	Omentum	Brain	Eyes	Uterus	Kidneys(2)	Kidney fat
29 weeks	Pre-treatment+		122	68	462	444	205	464	96.5	21.9	15.2	89.0	454
	Wt.	H.P.	137	27	748	562	102	306	97.2	27.3	41.4	97.0	292
		M.P.	121	29	695	549	79	112	91.6	23.0	24.2	95.0	129
		L.P.	101	22	492	375	46	80	96.6	26.1	21.6	73.2	109
50 weeks	% of L.P.	H.P.	136	123	152	150	221	383	101	105	192	133	267
		M.P.	120	132	141	146	172	140	95	88	112	130	118
	% of 29 week weight	H.P.	112	40	162	127	50	66	101	125	272	109	64
		M.P.	99	43	150	124	39	24	95	105	159	107	28
		L.P.	83	32	106	84	22	17	100	119	142	82	24
	Wt.	H.P.	191	57	1081	674	123	1147	106.5	32.9	36.8*	124.0	1040
		M.P.	190	30	1070	722	126	818	116.5	30.5	37.7*	116.1	797
		L.P.	171	52	840	681	114	725	96.5	28.9	26.6*	99.5	423
81 weeks	% of L.P.	H.P.	112	109	129	99	108	158	110	114	138	125	246
		M.P.	111	58	127	106	111	113	121	106	142	117	188
	% of 29 week weight	H.P.	157	84	234	152	60	247	110	150	242	139	229
		M.P.	156	44	232	163	61	176	121	139	248	130	176
		L.P.	140	76	182	153	56	156	100	132	175	112	93

+ Mean of two animals. * Uterus less vagina.

Table 42a

Actual weights of organs and their accompanying tissues from animals born 1957 and slaughtered for dissection; with H.P. and M.P. expressed as a percentage of Hill and 50 and 80 weeks as a percentage of 24 weeks. (Weights in gms.)

S.C.C.

Age	Treatment		Heart	Heart fat	Lungs + trachea	Liver	Spleen + diaphragm	Omentum	Brain	Eyes	Uterus	Kidneys(2)	Kidney fat
24 weeks	Pre-treatment+		114	32	615	421	48	241	85.4	23.1	16.9	82.5	320
	Wt.	H.P.	129	35	753	460	78	506	95.7	27.2	32.7	81.5	470
		M.P.	104	31	245	373	54	90	86.0	25.0	22.1	69.0	175
		Hill	116	39	495	401	109	59	90.7	24.8	22.5	78.5	91
50 weeks	% of Hill	H.P.	111	90	152	115	72	858	106	110	145	104	516
		M.P.	90	79	49	93	50	153	95	101	98	88	192
	% of 24 week weight	H.P.	113	109	122	109	163	210	112	118	193	99	147
		M.P.	91	97	40	89	113	37	101	108	131	84	55
		Hill	102	122	80	95	227	24	106	107	133	95	28
	Wt.	H.P.	156	52	705	638	219	754	98.0	31.0	39.5*	120.0	693
		M.P.	158	58	635	507	231	826	93.0	27.5	29.9*	82.0	852
		Hill	144	51	649	722	87	486	79.0	25.0	39.1*	101.0	497
80 weeks	% of Hill	H.P.	108	102	109	88	250	155	124	124	101	119	139
		M.P.	109	113	98	70	264	170	118	110	76	81	171
	% of 24 week weight	H.P.	137	163	115	152	456	313	115	134	234	145	217
		M.P.	139	181	103	120	481	343	109	119	177	99	266
		Hill	126	159	106	171	181	202	93	108	231	122	155

+Mean of two animals.

* Uterus less vagina.

Table 42a (contd.)

Actual weights of organs and their accompanying tissues from animals born 1957 and slaughtered for dissection; with H.P. and M.P. expressed as a percentage of Hill and 50 and 80 weeks as a percentage of 24 weeks. (Weights in gms.)

N.C.C.

Age	Treatment		Heart	Heart fat	Lungs + trachea	Liver	Spleen + diaphragm	Omentum	Brain	Eyes	Uterus	Kidneys(2)	Kidney fat
24 weeks	Pre-treatment+		122	19	702	508	120	242	78.9	22.5	11.3	97.5	222
50 weeks	Wt.	H.P.	135	52	662	457	95	545	84.2	25.1	23.7	90.4	649
		M.P.	125	26	599	421	65	87	96.0	26.1	20.4	73.2	110
		Hill	119	22	498	391	59	55	92.5	24.8	17.7	80.8	89
	% of Hill	H.P.	113	236	133	117	161	991	91	101	134	112	731
		M.P.	105	118	120	108	110	158	104	105	115	91	124
	% of 24 week weight	H.P.	111	274	94	90	79	225	107	112	210	93	292
		M.P.	102	137	85	83	54	36	122	116	181	75	50
		Hill	98	116	71	77	49	23	117	110	157	83	40
80 weeks	Wt.	H.P.	154	61	849	701	283	1218	97.5	29.0	37.8*	120.0	760
		M.P.	201	60	745	724	244	852	104.0	28.0	30.0*	125.5	646
		Hill	168	43	728	755	126	606	96.2	29.2	33.8*	125.0	404
	% of Hill	H.P.	92	141	117	93	224	201	101	99	112	96	188
		M.P.	120	140	102	96	193	141	108	96	89	100	160
	% of 24 week weight	H.P.	126	321	121	138	236	503	124	129	335	123	342
		M.P.	165	316	106	143	203	352	132	124	265	129	291
		Hill	138	226	104	149	105	250	122	130	299	128	182

+ Mean of two animals. * Uterus less vagina.

and tissue in the H.P. and M.P. animals at 12 and 18 months as a percentage of the weight of the same organ or tissue in the L.P./Hill animals and in all three treatment animals at the same two ages as a percentage of the weight of the same organ or tissue prior to treatment.

At 12 months, post-treatment, the organ least affected by the H.P. treatment relative to the L.P./Hill treatment was the brain, closely followed by the eyes, there being virtually no difference between the treatments in the weight of either of these organs. Of the other organs, the greatest difference was created in the spleen + diaphragm, followed by the lungs + trachea, the uterus + vagina, and the liver, while the kidneys and heart showed the least differences. Both these latter two organs are early maturing (Palsson and Verges, 1952) but not to the extent of the brain or eyes and did show some difference between the treatments at this time. Of the fat depots, heart fat was least affected by the H.P. treatment, possibly being a function of the weight of the heart, while omentum fat was most affected, averaging nearly twice as much relative to the kidney fat and five times as much relative to the heart fat.

Between the M.P. and L.P./Hill treatments the picture was nearly similar but on a smaller scale. The uterus + vagina, however, as well as the brain and eyes, showed practically no difference at this time, suggesting that a M.P. diet, unlike a H.P. diet, is incapable of accelerating growth in the reproductive organs any more than occurs on a L.P./Hill diet. Of the fat depots, heart fat was relatively high, furthering the suggestion that it is a function of the weight of the heart, while omentum fat was only slightly greater relative to the kidney fat and only half as much again relative to the heart fat.

Over the treatment period in the H.P. animals the organ which showed the greatest increase was the uterus + vagina, indicating the very great potential for growth inherent in the reproductive organs at this relatively late stage of development. The spleen + diaphragm, with one exception, appear to have decreased during this time, while the brain increased only slightly, particularly in the 1957 born animals, whose treatment started earlier. The kidneys showed the next greatest increase, followed by the liver, heart and eyes, all of which were very similar, while the lungs + trachea tended to be even higher. All three fat depots increased, heart fat showing the least and very similar to the heart itself, while omentum fat increased slightly more relative to the kidney fat.

In the M.P. animals the greatest increase was again shown by the uterus + vagina, followed by the eyes and lungs + trachea. The brain, kidneys, liver and heart all remained virtually the same weight and the spleen + diaphragm decreased. All three fat depots also decreased during this time, the greatest decrease being shown by the omentum fat and the smallest by the heart fat. In the L.P./Hill animals the greatest increase was again shown by the uterus + vagina which continued to grow at a time when the animal was losing weight considerably and growth had ceased in practically all parts, organs and tissues of the body. Only the eyes showed any increase and the brain also to a very limited extent, particularly in the 1957 born animals. All the other organs decreased during this time, with the greatest decrease again being shown by the spleen + diaphragm. The three fat depots also decreased, the omentum and kidney fats to a considerable extent and the former relatively more so than the latter.

At 18 months the differences between treatments had decreased considerably. Between the H.P. and L.P./Hill animals the greatest difference was still in the spleen + diaphragm, followed by the uterus less vagina and the lungs + trachea. The brain and eyes showed smaller differences, while the kidneys, heart and liver showed the smallest. In the fat depots the smallest difference was in heart fat, being very nearly the same, while in the omentum and kidney fats the differences between the treatments were still considerable, though not of the dimensions of 12 months, with little relative difference between the two depots. With one exception, a considerable one, the omentum fat tended to differ only slightly more relative to the kidney fat, an effect much reduced from that present at 12 months.

Between the M.P. and L.P./Hill animals the differences tended to follow a similar pattern to that shown between the H.P. and L.P./Hill animals above but on a slightly smaller scale, with the same breed difference apparent as was discussed earlier with regard to the body parts.

From prior to treatment to 18 months in the H.P. animals the uterus continued to show the greatest increase and the fact that at 18 months it was weighed without the vagina disguises what must be an even greater increase. The spleen + diaphragm gave some variable results at this time but this was due to a difference in cutting technique at slaughter in one year which could not be corrected for. The lungs + trachea still showed a considerable increase mainly created over the treatment period. There was not a great deal of difference between the relative increases of the liver, heart, eyes and kidneys, with the liver showing the greatest and the kidneys the smallest. The brain, however, showed the smallest increase of all. In the fat depots, heart fat increased similarly to the heart itself, while omentum and kidney fat increased considerably, the former relatively more so than the latter.

In the M.P. animals the picture was almost identical to that of the H.P. animals in relative increase of the various organs and tissues apart from omentum fat, whose increase was not so much greater relative to the other fat depots as it was in the H.P. animals. The L.P./Hill animals also showed a similar picture to that of the other two treatments with omentum fat increase not being much greater and kidney fat increase actually less relative to that of heart fat.

3. Weights at dissection of some carcass joints. The weights, both actual and as percentages of the total weight of all joints, of the head, fore-end, loin, pelvis, tail, two legs and four feet of the dissected animals at the three ages in both years are shown in Tables 43 and 43a. Prior to treatment

Table 43

Actual and percentage weights of joints from animals born 1956 and slaughtered for dissection. (Weights in gms.)

S.C.C.

Age			Total. All joints	Head	Fore-end	Loin	Pelvis	Tail	Legs(2)	Feet(4)
29 weeks	Pre-treatment*	Wt.	13884	1202	6390	1340	1305	65	3038	544
		% of total	100	8.7	46.0	9.7	9.4	0.5	21.9	3.9
50 weeks	H.P.	Wt.	19375	1771	9085	1687	1660	113	4287	772
		% of total	100	9.1	46.9	8.7	8.6	0.6	22.1	4.0
	M.P.	Wt.	14896	1498	6860	1234	1255	61	3262	726
		% of total	100	10.1	46.1	8.3	8.4	0.4	21.9	4.9
	L.P.	Wt.	11936	1317	5378	910	1129	41	2616	545
		% of total	100	11.0	45.1	7.6	9.5	0.3	21.9	4.6
81 weeks	H.P.	Wt.	23726	2088	11718	1968	2136	80	4873	863
		% of total	100	8.8	49.4	8.3	9.0	0.3	20.5	3.6
	M.P.	Wt.	21117	1816	10089	1938	2077	93	4378	726
		% of total	100	8.6	47.8	9.2	9.8	0.4	20.7	3.4
	L.P.	Wt.	19068	1680	8827	1743	1838	91	4117	772
		% of total	100	8.8	46.3	9.1	9.6	0.5	21.6	4.0

* Mean of two animals.

Table 43 (contd.)

Actual and percentage weights of joints from animals born 1956 and slaughtered for dissection. (Weights in gms.)

N.C.C.

Age			Total. All joints	Head	Fore-end	Loin	Pelvis	Tail	Legs(2)	Feet(4)
29 weeks	Pre-treatment*	Wt.	15288	1247	7023	1545	1405	59	3374	635
		% of total	100	8.2	45.9	10.1	9.2	0.4	22.1	4.2
	H.P.	Wt.	19889	1816	9169	1693	1949	74	4416	772
		% of total	100	9.1	46.1	8.5	9.8	0.4	22.2	3.9
50 weeks	M.P.	Wt.	17197	1680	7858	1532	1467	74	3814	772
		% of total	100	9.8	45.7	8.9	8.5	0.4	22.2	4.5
	L.P.	Wt.	13837	1544	6419	1106	1138	49	2900	681
		% of total	100	11.2	46.4	8.0	8.2	0.4	21.0	4.9
	H.P.	Wt.	26736	2088	13135	2460	2777	109	5304	863
		% of total	100	7.8	49.1	9.2	10.4	0.4	19.8	3.2
81 weeks	M.P.	Wt.	23993	2134	11803	2124	2351	91	4718	772
		% of total	100	8.9	49.2	8.9	9.8	0.4	19.7	3.2
	L.P.	Wt.	21752	1952	10503	2066	2048	82	4284	817
		% of total	100	9.0	48.3	9.5	9.4	0.4	19.7	3.8

* Mean of two animals.

Table 43a

Actual and percentage weights of joints from animals born 1957 and slaughtered for dissection. (Weights in gms.).

S.C.C.

Age			Total. All joints	Head	Fore-end	Loin	Pelvis	Tail	Legs(2)	Feet(4)
24 weeks	Pre-treatment*	Wt.	13661	1226	6534	1276	1211	68	2869	477
		% of total	100	9.0	47.8	9.3	8.9	0.5	21.0	3.5
	H.P.	Wt.	19159	1680	9310	1930	1727	100	3731	681
		% of total	100	8.8	48.6	10.1	9.0	0.5	19.5	3.5
50 weeks	M.P.	Wt.	14137	1544	6493	1247	1243	47	2973	590
		% of total	100	10.9	45.9	8.8	8.8	0.4	21.0	4.2
	Hill	Wt.	12260	1407	5461	1070	1052	35	2645	590
		% of total	100	11.5	44.5	8.7	8.6	0.3	21.6	4.8
	H.P.	Wt.	22444	1907	10834	2242	2234	111	4435	681
		% of total	100	8.5	48.3	10.0	9.9	0.5	19.8	3.0
80 weeks	M.P.	Wt.	20025	1680	9647	1951	2078	87	3901	681
		% of total	100	8.4	48.2	9.7	10.4	0.4	19.5	3.4
	Hill	Wt.	19136	1725	9231	1842	1881	73	3612	772
		% of total	100	9.0	48.2	9.6	9.8	0.4	18.9	4.1

* Mean of two animals.

Table 43a (contd.)

Actual and percentage weights of joints from animals born 1957 and slaughtered for dissection. (Weights in gms.)

N.C.C.

Age			Total. All joints	Head	Fore-end	Loin	Pelvis	Tail	Legs(2)	Feet(4)
24 weeks	Pre-treatment*	Wt.	15332	1362	7110	1376	1405	67	3331	681
		% of total	100	8.9	46.4	9.0	9.2	0.4	21.7	4.4
50 weeks	H.P.	Wt.	22420	1771	10868	2195	2148	83	4492	863
		% of total	100	7.9	48.5	9.8	9.6	0.4	20.0	3.8
	M.P.	Wt.	14878	1634	6633	1240	1357	50	3238	726
		% of total	100	11.0	44.6	8.3	9.1	0.3	21.8	4.9
	Hill	Wt.	12306	1453	5325	1046	1074	41	2777	590
		% of total	100	11.8	43.3	8.5	8.7	0.3	22.6	4.8
80 weeks	H.P.	Wt.	25069	2043	12090	2389	2600	125	5050	772
		% of total	100	8.2	48.2	9.5	10.4	0.5	20.1	3.1
	M.P.	Wt.	23225	1861	11041	2378	2439	111	4578	817
		% of total	100	8.0	47.5	10.3	10.5	0.5	19.7	3.5
	Hill	Wt.	21064	1816	10093	2146	2029	77	4177	726
		% of total	100	8.6	47.9	10.2	9.6	0.4	19.8	3.5

* Mean of two animals.

the relative proportions of the various joints were similar in both breeds and both years. Very minor exceptions to this were present in the loin and feet. In the former the earlier start to the treatment period in 1957 resulted in this later developing joint being very slightly lighter relative to 1956, while in the feet, the N.C.C. animals were relatively heavier than the S.C.C. animals. Generally, the fore-end constituted on average 46 - 47% of the total joints at this time, the two legs 22%, the head just under 9%, the loin and the pelvis both between 9% and 9½%, the tail ½% and the four feet 4%.

At 12 months, post-treatment, the head and feet both constituted a smaller percentage of the total joints in the H.P. animals than they did in the M.P. and L.P./Hill animals, which differed only slightly, with the L.P./Hill being the greater. The fore-end constituted a greater percentage of the total joints in the H.P. animals than it did in those of the other two treatments, which again were very similar, with the L.P./Hill animals just the lesser. This suggests that the fore-end of the animal is later developing than the hindquarters and therefore responded more to the H.P. and M.P. treatments during this time. This is borne out by the very little difference in relative proportion of the legs in each treatment, which is in agreement with Palsson and Verges' (1952) findings that the legs are earlier maturing in the sheep than are the shoulders and neck. However, both the loin and the pelvis joints also constituted greater percentages of the total joints in the H.P. animals than they did in the M.P. and L.P./Hill animals, particularly in the loin, where the percentage in the latter treatment was smaller than that of the pelvis, although both were similar in the H.P. animals. This again is in agreement with Palsson and Verges (1952), that the loin is later developing than the pelvis and is capable of responding more to treatment during this time. The tail also showed a greater percentage in the H.P. animals, with the M.P. animals being intermediate, a result almost certainly due to fat deposition in the better treatments but differences in length from variable docking may have an influence.

At 18 months, the picture was the same in the head and feet as it was at 12 months but with the differences much reduced and the proportions much smaller, indicating less growth from 12 - 18 months relative to the other joints. The legs continued to constitute a similar but now smaller proportion in all treatments, while the tail now also constituted a similar proportion regardless of treatment. The fore-end differences in proportion had almost disappeared by 18 months but still ranged slightly in the same order, being greater in the H.P. and M.P. animals. In the loin, however, the H.P. animals now possessed the smallest proportion and the L.P./Hill animals the greatest, indicating the very considerable growth experienced by this joint subsequent to treatment in animals where growth was retarded during the treatment period, although the differences between the treatments in these relative proportions were not great. In the pelvis the proportion was greater than at 12 months in all treatments and still showed slight differences, with the H.P. and M.P. animals possessing a greater proportion than the L.P./Hill animals.

To eliminate the interactions that are present in the relative proportions of the joints within the whole, Tables 44 and 44a show the weight of each joint at 12 and 18 months in the H.P. and M.P. animals as a percentage of the weight of the same joint in the L.P./Hill animals and in all three treatment animals at each age as a percentage of the weight of the same joint prior to treatment.

While the differences in weight tended to be greater after treatment at 12 months between the 1957 born H.P. and Hill animals than between the 1956 born H.P. and L.P. animals, particularly in the total joints, fore-end, loin, pelvis and tail but not in the head, legs and feet, the relative differences followed similar patterns in both years. The greatest difference between these treatments was created in the tail, followed by the loin and then the fore-end and pelvis which were very similar. Next came the total joints and legs, while the smallest differences were created in the feet and head. The great

Table 44

Weights of joints from animals born 1956 and slaughtered for dissection.
H.P. and M.P. expressed as a percentage of L.P.
and 50 and 81 weeks as a percentage of 29 weeks.

S.C.C.

Age	Treatment		Total. All joints	Head	Fore-end	Loin	Pelvis	Tail	Legs(2)	Feet(4)
50 weeks	(% of	(H.P.	162	134	169	185	147	276	164	142
	(L.P.	(M.P.	125	114	128	136	111	149	125	133
	(% of	(H.P.	139	147	142	126	127	174	141	142
	(29 week	(M.P.	107	125	107	92	96	94	107	133
	(weight	(L.P.	86	110	84	68	87	63	86	100
81 weeks	(% of	(H.P.	124	124	133	113	116	88	118	112
	(L.P.	(M.P.	111	108	114	111	113	102	106	94
	(% of	(H.P.	171	174	183	147	164	123	160	159
	(29 week	(M.P.	152	151	158	145	159	143	144	133
	(weight	(L.P.	137	140	138	130	141	140	136	142

N.C.C.

Age	Treatment		Total. All joints	Head	Fore-end	Loin	Pelvis	Tail	Legs(2)	Feet(4)
50 weeks	(% of	(H.P.	144	118	143	153	171	151	152	113
	(L.P.	(M.P.	124	109	122	139	129	151	132	113
	(% of	(H.P.	130	146	131	110	139	125	131	122
	(29 week	(M.P.	112	135	112	99	104	125	113	122
	(weight	(L.P.	91	124	91	72	81	83	86	107
81 weeks	(% of	(H.P.	123	107	125	119	136	133	124	106
	(L.P.	(M.P.	110	109	112	103	115	111	110	94
	(% of	(H.P.	175	167	187	159	198	185	157	136
	(29 week	(M.P.	157	171	168	137	167	154	140	122
	(weight	(L.P.	142	157	150	134	146	139	127	129

Table 44a

Weights of joints from animals born 1957 and slaughtered for dissection.
H.P. and M.P. expressed as a percentage of Hill
and 50 and 80 weeks as a percentage of 24 weeks.

Age	Treatment		Total. All joints	Head	Fore-end	Loin	Pelvis	Tail	Legs(2)	Feet(4)
					S.C.C.					
50 weeks	(% of Hill	(H.P.	156	119	170	180	164	286	141	115
		(M.P.	115	110	119	117	118	134	112	100
	(% of 24 week weight	(H.P.	140	137	142	151	143	147	130	143
		(M.P.	103	126	99	98	103	69	104	124
		(Hill	90	115	84	84	87	51	92	124
80 weeks	(% of Hill	(H.P.	117	111	117	122	119	152	123	88
		(M.P.	105	97	105	106	110	119	108	88
	(% of 24 week weight	(H.P.	164	156	166	176	184	163	155	143
		(M.P.	147	137	148	153	172	128	136	143
		(Hill	140	141	141	144	155	107	126	162
					N.C.C.					
50 weeks	(% of Hill	(H.P.	182	122	204	210	200	202	162	146
		(M.P.	121	112	125	119	126	122	117	123
	(% of 24 week weight	(H.P.	146	130	153	160	153	124	135	127
		(M.P.	97	120	93	90	97	75	97	107
		(Hill	80	107	75	76	76	61	83	87
80 weeks	(% of Hill	(H.P.	119	113	120	111	128	162	121	106
		(M.P.	110	102	109	111	120	144	110	113
	(% of 24 week weight	(H.P.	164	150	170	174	185	187	152	113
		(M.P.	151	137	155	173	174	166	137	120
		(Hill	137	133	142	156	144	115	125	107

difference in the tail may be due to considerable fat deposition but comparisons of this joint are of doubtful value in view of the docking which is carried out at marking time and may lead to variations in length. There is an apparent breed difference in the pelvis joint, the S.C.C. animals showing smaller differences between the H.P. and L.P./Hill treatments than was the case with the N.C.C. animals. This was due to a slightly greater development in the S.C.C. L.P./Hill animals and a slightly smaller development in the S.C.C. H.P. animals, suggesting that treatment has had less effect on the growth and development of this joint in the S.C.C. breed than it has in the N.C.C. breed and that the former may therefore be earlier maturing than the latter in this respect.

Between the M.P. and L.P./Hill animals the 1956 born individuals showed slightly greater differences than the 1957 born, the very opposite of the above picture with the H.P. animals. This was so in practically all joints apart from the head but it had no effect on the overall relative differences, which followed similar patterns in both years. The differences between these treatments were much smaller than between the H.P. and L.P./Hill treatments with very much less variation, the greatest difference being again in the tail, followed by the loin, which was little more than the fore-end, legs, pelvis and total joints, all of which were similar, while the feet and head showed the least differences. The breed difference in the pelvis joint was apparent here also, for the same reason as was discussed above.

Over the treatment period in the H.P. animals all joints showed remarkably similar increases, ranging on average from 34% to 43%, with the legs and feet showing the least increases and the tail and fore-end the greatest. In the M.P. animals the head and feet showed the greatest increases, while the total joints, legs and fore-end all gained a slight and similar amount. The pelvis remained unchanged and the loin and tail both appeared to decrease in weight during this time. In the L.P./Hill animals the relative changes in weight followed a similar pattern to that of the M.P. animals, with the head and feet increasing but all other joints decreasing, the total joints, legs, fore-end and pelvis to a similar degree and the loin and tail very much more so.

Over the treatment period then, it would appear that the tail and loin are more affected by treatment than the fore-end and pelvis which respond very similarly, while the legs are less affected than any of these four joints. This indicates the earlier maturity of the legs relative to the whole fore-end and the pelvis which are both earlier maturing than the loin and tail, all of which agrees with the findings of most other workers.

At 18 months the differences between treatments had decreased considerably. Between the H.P. and L.P./Hill animals the greatest difference still tended to be in the tail, followed by the pelvis, fore-end, legs and total joints, all of which were very similar. The difference in the loin, however, was very much reduced at this time compared with that at 12 months, almost certainly due to the late developing nature of this joint enabling it to recover rapidly over the summer after a L.P. or Hill wintering. The difference in the head at this time was very little less than that of the loin but here it was due to the very limited treatment effect over the winter period on a joint of very early maturity. The least difference between these treatments was shown in the feet.

Between the M.P. and L.P./Hill animals the differences tended to follow a similar pattern to that above but on a smaller scale. Only the pelvis difference was a little greater than that of the total joints, fore-end and legs, while the loin difference was now similar to that of the latter three. The breed difference discussed earlier in the pelvis joint at 12 months was still apparent at 18 months, being particularly obvious between the H.P. and L.P./ Hill animals.

From prior to treatment to 18 months in the H.P. animals the greatest increase was shown in the pelvis and fore-end. This is an interesting result in view of their earlier maturity relative to the loin and tail as discussed at 12 months above. A possible explanation for this is that on a H.P. diet they had largely achieved by 12 months their potential for growth and development in bone and muscle and over the summer fat was laid down in considerable quantities causing a relatively greater increase in weight than in the later developing joints whose weight increase was due mostly to bone and muscle, their stage of growth and development not having reached the time when fat, the latest developing tissue, had a high potential for development. Next in order of increase came the total joints, followed by the tail, loin, head and legs, with the smallest increase being shown by the feet.

In the M.P. animals the picture was very similar, with the pelvis and fore-end showing the greatest increases, followed by the loin, total joints, head and tail, all of which increased by approximately the same relative amount, with the legs and feet showing the smallest increases. In the L.P./Hill animals the relative differences between the joints were much reduced and in general by 18 months these animals had increased to approximately the same degree as the H.P. animals had at 12 months in the weight of most of the joints, only the tail showing any difference of note. Even in these treatments the pelvis just showed the greatest increase and apart from the tail which showed the least and the legs and feet which were very little greater, all other joints increased by similar relative amounts.

4. <u>Weights of tissues dissected from hindquarter joints</u>. The total weights of muscle, subcutaneous fat, intermuscular fat, bone and tendon dissected from the hindquarters at the three ages in both years are shown in Table 45 as percentages of the total weight of the hindquarters.

Prior to treatment the proportions of the tissues were fairly constant in both breeds and both years, with muscle constituting on average 67% of the total, bone nearly 11%, tendon 2%, intermuscular fat just over 8% and subcutaneous fat 10%. At 12 months, post-treatment, in the H.P. animals, the

Table 45

Percentage weights of muscle, fat, bone and tendon dissected from the hindquarters of animals born 1956 and 1957.

Age	Treatment	Muscle	Subcutaneous fat	Intermuscular fat	Bone	Tendon, etc.	Loss in dissection
Born 1956							
S.C.C.							
29 weeks	Pre-treatment*	67.2	10.2	8.0	10.2	2.1	2.3
50 weeks	H.P.	69.8	8.7	6.1	11.0	2.9	1.5
	M.P.	69.2	5.7	7.8	13.1	2.5	1.7
	L.P.	71.5	4.0	5.5	14.4	2.7	1.9
81 weeks	H.P.	65.7	13.9	7.1	10.5	2.0	0.8
	M.P.	67.0	11.7	8.2	10.3	1.7	1.1
	L.P.	70.0	8.9	7.9	10.4	1.8	1.0
N.C.C.							
29 weeks	Pre-treatment*	67.8	10.4	7.9	10.5	2.1	1.3
50 weeks	H.P.	69.8	7.5	7.2	10.8	2.8	1.9
	M.P.	69.5	6.6	6.5	11.9	3.5	2.0
	L.P.	70.1	4.2	7.8	13.5	2.9	1.5
81 weeks	H.P.	64.7	12.7	10.0	9.8	1.7	1.1
	M.P.	66.6	11.3	8.5	10.5	2.2	0.9
	L.P.	61.3	17.3	8.5	9.9	1.8	1.2
Born 1957							
S.C.C.							
24 weeks	Pre-treatment*	65.6	10.2	9.5	10.9	2.1	1.7
50 weeks	H.P.	65.2	10.8	11.0	10.1	2.2	0.7
	M.P.	70.5	4.9	9.3	12.5	1.8	1.0
	Hill	72.6	2.7	7.2	14.2	2.1	1.2
80 weeks	H.P.	65.6	13.3	8.6	9.7	2.1	0.7
	M.P.	65.8	11.8	9.4	10.8	1.6	0.6
	Hill	67.1	10.8	8.4	10.8	2.1	0.8
N.C.C.							
24 weeks	Pre-treatment*	69.0	8.8	7.6	11.6	1.7	1.3
50 weeks	H.P.	62.8	14.9	9.4	9.9	2.1	0.9
	M.P.	71.2	4.8	8.3	12.6	1.8	1.3
	Hill	73.3	2.5	7.1	13.0	2.7	1.4
80 weeks	H.P.	68.1	11.7	7.6	10.3	1.7	0.6
	M.P.	64.8	13.5	9.5	9.6	2.0	0.6
	Hill	66.0	12.8	8.0	10.5	1.9	0.8

* Mean of two animals.

proportions of the tissues were on average the same as prior to treatment. In the 1957 born animals, however, there was a greater percentage of fat and conversely a smaller percentage of muscle and bone than in the 1956 born animals, due to the former's longer and higher standard of treatment.

In the M.P. animals at 12 months the percentage of subcutaneous fat was very much smaller than in the H.P. animals and the percentage of intermuscular fat was slightly smaller, while the percentages of muscle and bone were conversely much greater. There was little apparent difference between the years in this treatment. In the L.P./Hill animals the fat percentages were even smaller than in the M.P. animals, particularly in subcutaneous fat, while muscle and bone constituted even greater percentages of the total. In the 1957 born Hill animals, however, there was a greater percentage of muscle and a smaller percentage of subcutaneous fat than in the 1956 born L.P. animals, due to the former's longer and severer treatment.

At 18 months there was very little difference on average between the treatments in the relative proportions of the different tissues, with muscle constituting 66% of the total, bone 10%, intermuscular fat between 8% and 9%, similar to the pre-treatment proportion, and subcutaneous fat between 12% and 13%. The latter tissue was the only one to alter much between 6 and 18 months relative to the others. In the L.P./Hill wintered animals there was apparently a breed difference in subcutaneous fat, the N.C.C. animals showing a greater percentage than the S.C.C. animals, balanced by a slightly smaller percentage of both muscle and bone in the former. This was probably due to chance as subcutaneous fat shows a great facility to fluctuate rapidly with variations in diet and the N.C.C. individuals selected were fatter than the S.C.C.

Tables 46 and 46a show the weight of each tissue at 12 and 18 months in the H.P. and M.P. animals as a percentage of the weight of the same tissue in the L.P./Hill animals and in all three treatment animals at each age as a percentage of the weight of the same tissue prior to treatment. Between the H.P.

Table 46

Weights of muscle, fat, bone and tendon dissected from the hindquarters of animals born 1956. H.P. and M.P. expressed as a percentage of L.P. and 50 and 81 weeks as a percentage of 29 weeks.

Age	Treatment		Total	Muscle	Subcutaneous fat	Intermuscular fat	Bone	Tendon, etc.	Loss in dissection
					S.C.C.				
50 weeks	% of L.P.	H.P.	165	161	360	184	126	175	134
		M.P.	124	120	179	176	113	113	111
	% of 29 week weight	H.P.	135	140	115	103	145	182	89
		M.P.	101	104	57	99	130	117	74
		L.P.	82	87	32	56	115	104	67
81 weeks	% of L.P.	H.P.	116	109	182	105	117	131	93
		M.P.	109	104	144	113	108	103	118
	% of 29 week weight	H.P.	158	154	215	140	162	151	57
		M.P.	148	147	170	151	148	118	73
		L.P.	136	141	118	134	138	115	62
					N.C.C.				
50 weeks	% of L.P.	H.P.	157	156	278	144	125	155	197
		M.P.	133	132	207	110	117	163	173
	% of 29 week weight	H.P.	127	131	92	115	130	175	195
		M.P.	108	111	69	88	121	184	171
		L.P.	81	84	33	80	104	113	99
81 weeks	% of L.P.	H.P.	126	133	92	147	124	119	116
		M.P.	109	119	72	109	117	134	87
	% of 29 week weight	H.P.	167	159	204	210	155	140	141
		M.P.	145	143	158	156	145	157	105
		L.P.	133	120	221	143	125	118	121

Table 46a

Weights of muscle, fat, bone and tendon dissected from the hindquarters of animals born 1957. H.P. and M.P. expressed as a percentage of Hill and 50 and 80 weeks as a percentage of 24 weeks.

Age	Treatment		Total	Muscle	Subcutaneous fat	Intermuscular fat	Bone	Tendon, etc.	Loss in dissection
					S.C.C.				
50 weeks	% of Hill	H.P.	156	140	616	239	111	162	98
		M.P.	115	111	207	148	101	96	98
	% of 24 week weight	H.P.	138	137	146	159	127	148	59
		M.P.	102	109	49	99	116	88	59
		Hill	89	98	24	67	115	91	60
80 weeks	% of Hill	H.P.	122	119	150	124	110	121	105
		M.P.	108	106	118	122	109	79	82
	% of 24 week weight	H.P.	166	167	217	149	147	170	68
		M.P.	148	148	171	146	146	111	53
		Hill	137	140	145	120	134	141	65
					N.C.C.				
50 weeks	% of Hill	H.P.	181	155	1072	240	137	142	114
		M.P.	119	116	227	140	116	77	114
	% of 24 week weight	H.P.	144	131	244	179	123	184	100
		M.P.	95	98	52	104	103	100	100
		Hill	80	85	23	75	89	130	88
80 weeks	% of Hill	H.P.	121	124	110	115	118	110	93
		M.P.	113	111	119	134	103	122	75
	% of 24 week weight	H.P.	165	162	219	165	145	169	83
		M.P.	154	144	236	193	127	186	66
		Hill	136	130	199	144	123	153	89

and L.P./Hill animals the greatest difference after treatment at 12 months was created in subcutaneous fat, followed by intermuscular fat, both of which showed greater differences in the 1957 born than in the 1956 born animals. The next greatest difference was in the total tissues, followed by tendon and muscle, while the tissue least affected by treatment was bone. Between the M.P. and L.P./Hill animals the differences were very much smaller, particularly in the two types of fat. In spite of this, the greatest difference was again in subcutaneous fat, followed by intermuscular fat, with the total tissues and muscle next in order and bone and tendon showing the least differences.

Over the treatment period in the H.P. animals the greatest increase was apparently in tendon but as the dissection of this tissue was rather inaccurate it is not intended to elaborate on this. Of the other tissues, subcutaneous fat showed the greatest increase, followed by intermuscular fat, the total tissues and muscle, with bone showing the smallest increase. In the M.P. animals, tendon again showed the greatest increase, closely followed in this case by bone, with muscle showing generally a limited increase, while the total tissues and intermuscular fat remained virtually unchanged. Subcutaneous fat, however, decreased during this time by almost half. This illustrates the ability of the growing animal on a M.P. or maintenance diet, when its total live weight is only being maintained, to continue bone growth at the expense of its fatty tissues. In the L.P./Hill animals, tendon and bone both increased, while muscle and then the total tissues decreased to a limited extent and the two types of fat decreased considerably, particularly subcutaneous fat.

At 18 months the differences between treatments had decreased considerably. Between the H.P. and L.P./Hill animals, subcutaneous fat still showed the greatest difference in the S.C.C. breed but apparently not in the N.C.C. breed where an excessively fat individual was unfortunately selected in one year to represent the L.P. treatment and gave an unavoidable bias to any fat comparisons. Intermuscular fat, muscle, the total tissues and tendon all showed on average very similar differences, while bone continued to show the least difference. Between the M.P. and L.P./Hill animals the picture was very similar but on a smaller scale, although generally the greatest difference here was shown by intermuscular fat, followed by subcutaneous fat, with the other three tissues and the total tissues all showing similar differences.

From prior to treatment to 18 months the relative increases in the various tissues followed a similar pattern in all three treatments, with subcutaneous fat showing the greatest increase, followed by intermuscular fat, the total tissues, muscle and tendon, while bone showed the least increase. The most interesting point here is the tremendous increase in fat deposition, particularly subcutaneous fat, which has obviously occurred over the summer from 12 - 18 months in the M.P. and L.P./Hill animals.

Having shown above the effects of treatment on the relative changes in weight of the tissues in the total hindquarters, Tables 47 and 47a show now the weight of muscle, fat and bone in each separate joint in the hindquarters of the H.P. and M.P. animals at 12 and 18 months as a percentage of the weight of the respective tissues in the L.P./Hill animals and in all three treatment animals at each age as a percentage of the weight of the respective tissues prior to treatment. Between the H.P. and L.P./Hill animals the greatest differences after treatment at 12 months in all three joints, loin, pelvis and leg, were created in the two fats, with the least difference in bone. However, in muscle there was a greater difference between the treatments in the loin than there was in either of the other two joints, which were very similar. In subcutaneous fat, the loin showed very much the greatest difference with the pelvis intermediate and the leg showing the least difference. This was also the case in intermuscular fat but with much smaller relative differences. In bone, both the loin and the pelvis showed similar differences, which were double that present in the leg. Between the M.P. and L.P./Hill animals the

Table 47

Weights of muscle, fat and bone dissected from the hindquarter joints of animals born 1956. H.P. and M.P. expressed as a percentage of L.P. and 50 and 81 weeks as a percentage of 29 weeks.

S.C.C.

Age	Treatment		Joint	Muscle	Subcutaneous fat	Intermuscular fat	Bone
50 weeks	% of L.P.	H.P.	Loin	175	967	396	131
			Pelvis	140	252	174	129
			Leg*	164	342	146	123
		M.P.	Loin	129	300	393	108
			Pelvis	110	117	129	106
			Leg*	120	200	165	117
	% of 29 week weight	H.P.	Loin	140	86	81	142
			Pelvis	137	93	114	154
			Leg*	141	151	112	143
		M.P.	Loin	103	27	80	117
			Pelvis	108	43	85	126
			Leg*	103	88	126	136
		L.P.	Loin	80	9	20	108
			Pelvis	98	37	66	119
			Leg*	86	44	76	116
81 weeks	% of L.P.	H.P.	Loin	103	188	107	115
			Pelvis	109	207	62	120
			Leg*	112	161	146	117
		M.P.	Loin	106	148	117	113
			Pelvis	103	156	123	111
			Leg*	104	132	100	104
	% of 29 week weight	H.P.	Loin	146	180	139	142
			Pelvis	163	257	89	173
			Leg*	154	208	186	164
		M.P.	Loin	150	142	153	139
			Pelvis	155	194	178	160
			Leg*	143	171	127	147
		L.P.	Loin	141	96	130	123
			Pelvis	150	124	144	144
			Leg*	138	129	127	141

* Mean of two legs/animal.

Table 47 (contd.)

Weights of muscle, fat and bone dissected from the hindquarter joints of animals born 1956. H.P. and M.P. expressed as a percentage of L.P. and 50 and 81 weeks as a percentage of 29 weeks.

N.C.C.

Age	Treatment		Joint	Muscle	Subcutaneous fat	Intermuscular fat	Bone
50 weeks	% of L.P.	H.P.	Loin	150	282	139	130
			Pelvis	162	420	178	139
			Leg*	155	230	121	119
		M.P.	Loin	140	207	81	113
			Pelvis	127	209	121	123
			Leg*	130	206	118	116
	% of 29 week weight	H.P.	Loin	117	69	76	122
			Pelvis	148	92	127	138
			Leg*	131	107	152	130
		M.P.	Loin	109	51	44	106
			Pelvis	116	46	86	122
			Leg*	109	96	148	126
		L.P.	Loin	78	25	54	94
			Pelvis	92	22	71	99
			Leg*	84	46	125	109
81 weeks	% of L.P.	H.P.	Loin	127	83	146	132
			Pelvis	143	93	216	136
			Leg*	131	99	107	118
		M.P.	Loin	114	61	113	126
			Pelvis	125	77	151	123
			Leg*	119	76	81	111
	% of 29 week weight	H.P.	Loin	146	216	202	142
			Pelvis	189	240	210	177
			Leg*	154	169	224	151
		M.P.	Loin	131	159	155	135
			Pelvis	165	197	147	161
			Leg*	140	130	169	142
		L.P.	Loin	115	260	138	107
			Pelvis	132	257	97	131
			Leg*	118	170	208	128

* Mean of two legs/animal.

Table 47a

Weights of muscle, fat and bone dissected from the hindquarter joints of animals born 1957. H.P. and M.P. expressed as a percentage of Hill and 50 and 80 weeks as a percentage of 24 weeks.

S.C.C.

Age	Treatment		Joint	Muscle	Subcutaneous fat	Intermuscular fat	Bone
50 weeks	% of Hill	H.P.	Loin	150	977	366	138
			Pelvis	141	1007	192	110
			Leg*	135	378	206	102
		M.P.	Loin	112	336	159	100
			Pelvis	111	225	153	106
			Leg*	111	163	137	100
	% of 24 week weight	H.P.	Loin	148	173	175	146
			Pelvis	146	143	149	132
			Leg*	130	135	154	119
		M.P.	Loin	110	60	76	106
			Pelvis	115	32	119	126
			Leg*	107	58	102	116
		Hill	Loin	99	18	48	106
			Pelvis	103	14	78	119
			Leg*	96	36	75	116
80 weeks	% of Hill	H.P.	Loin	117	144	172	104
			Pelvis	115	153	106	104
			Leg*	122	152	110	114
		M.P.	Loin	105	117	131	105
			Pelvis	104	112	134	116
			Leg*	108	126	101	106
	% of 24 week weight	H.P.	Loin	171	319	158	138
			Pelvis	188	216	158	160
			Leg*	157	163	132	145
		M.P.	Loin	153	258	121	140
			Pelvis	170	157	201	178
			Leg*	139	136	121	136
		Hill	Loin	146	221	92	133
			Pelvis	163	141	150	153
			Leg*	129	108	120	128

* Mean of two legs/animal.

Table 47a (contd.)

Weights of muscle, fat and bone dissected from the hindquarter joints of animals born 1957. H.P. and M.P. expressed as a percentage of Hill and 50 and 80 weeks as a percentage of 24 weeks.

N.C.C.

Age	Treatment		Joint	Muscle	Subcutaneous fat	Intermuscular fat	Bone
50 weeks	% of Hill	H.P.	Loin	167	3500	225	144
			Pelvis	150	2529	268	164
			Leg*	152	500	229	126
		M.P.	Loin	117	392	129	109
			Pelvis	120	547	129	119
			Leg*	114	148	158	116
	% of 24 week weight	H.P.	Loin	136	313	180	129
			Pelvis	126	269	233	132
			Leg*	131	190	145	117
		M.P.	Loin	95	35	103	97
			Pelvis	100	58	112	96
			Leg*	99	56	100	108
		Hill	Loin	82	9	80	89
			Pelvis	84	11	87	81
			Leg*	87	38	63	93
80 weeks	% of Hill	H.P.	Loin	119	91	142	101
			Pelvis	129	130	113	134
			Leg*	125	114	99	118
		M.P.	Loin	110	103	174	86
			Pelvis	112	145	133	113
			Leg*	110	113	110	106
	% of 24 week weight	H.P.	Loin	163	275	192	141
			Pelvis	176	268	189	163
			Leg*	156	157	133	140
		M.P.	Loin	152	310	236	120
			Pelvis	153	298	223	137
			Leg*	138	156	147	126
		Hill	Loin	137	302	136	140
			Pelvis	136	206	168	122
			Leg*	125	138	134	119

* Mean of two legs/animal.

range of relative differences, although much smaller, followed a similar pattern to that described above between the H.P. and L.P./Hill animals, with only one exception. This was in bone, where the loin showed a smaller difference than was present in the other two joints, which were nearly similar.

Over the treatment period in the H.P. animals, muscle and bone increased to a similar extent in the loin and also in the pelvis, with very little difference between the joints. In the leg, muscle increase was again almost the same as in the other two joints but bone increase tended to be less, particularly in the 1957 born animals. The fats gave very varied results due to the differences between the years in degree of treatment. In the 1956 born animals, reared on a less fattening diet than the other age group, subcutaneous fat decreased in the loin to a considerable extent and in the pelvis to a limited extent, while increasing in the leg. Intermuscular fat also decreased in this age group in the loin but increased in the other two joints. In the 1957 born animals, subcutaneous fat increased considerably in the loin, slightly less in the pelvis and least in the leg, being only very little more than the other age group in the latter joint. Intermuscular fat tended to show a similar pattern with one exception in the 1957 born N.C.C. pelvis, where the increase was larger than in any other case.

In the M.P. animals during this time muscle increased very slightly and to a similar extent in the loin and leg but by twice as much in the pelvis. Bone increase was greatest in the leg and very much greater than that of muscle, while it was slightly less in the pelvis, although still greater than muscle, and least in the loin, where it was very similar to muscle. Subcutaneous fat decreased in all three joints, very greatly and to a similar extent in the loin and pelvis but much less so in the leg. Intermuscular fat decreased in the loin in both years and in the pelvis in the 1956 born animals but increased in the pelvis in the 1957 born animals and in the leg in both years.

In the L.P./Hill animals during this time muscle decreased in all three joints, more so in the loin and leg than in the pelvis. Bone on average appeared to remain unchanged in the loin, the S.C.C. animals actually increasing and the N.C.C. animals decreasing but this could be due to the differences in bone between the breeds prior to treatment. In the pelvis, bone on average increased slightly and tended to do so as much, if not even more so, in the leg. Subcutaneous fat had practically disappeared from the loin and there was very little more on the pelvis, while on the leg it had decreased to less than half of the pre-treatment level. Intermuscular fat was not quite so severely hit, dropping on average to 50% of the pre-treatment level in the loin but decreasing by very much less in the pelvis and least of all in the leg.

Between the H.P. and L.P./Hill animals at 18 months the difference in loin muscle had decreased to a greater extent than that of pelvis and leg muscle which were still similar but reduced in difference compared with the 12 month situation. This is of interest in that treatment had created the greatest difference in loin muscle relative to that of the other two joints at 12 months but subsequent to treatment it showed very much greater powers of recovery than the latter. This was also the case in bone in the loin, where the difference between the treatments decreased more than it did in the pelvis, while leg bone remained unchanged from the 12 month difference. In subcutaneous fat the differences were very much reduced from 12 months in all three joints, particularly in the loin and pelvis, with the greatest difference now in the pelvis and the other two joints very similar. In intermuscular fat the differences were also reduced from 12 months in all three joints but to a lesser degree than in subcutaneous fat, with the loin showing the greatest difference but not much between the pelvis and leg.

Between the M.P. and L.P./Hill animals at 18 months the differences in muscle had decreased in all three joints and were very similar. In bone the differences between these treatments were the same at this time as they were at 12 months in both the loin and the pelvis, while in the leg the difference had decreased slightly and was now similar to that in the loin. In subcutaneous fat the differences had decreased in all joints, more so in the loin, which now showed the smallest difference, than in the other two joints, where the greatest difference was in the pelvis, duplicating on a smaller scale the picture discussed above between the H.P. and L.P./Hill animals. In intermuscular fat the difference had disappeared in the leg and was reduced in the loin, while it had remained unchanged in the pelvis, resulting in the latter two joints showing the same difference at this time.

From prior to treatment to 18 months in the H.P. animals, muscle increased to a greater extent in the pelvis than it did in the other two joints, where the increase was similar, this being an extension of the trends appearing at 12 months. Muscle also appeared to have increased more than bone during this time in all joints and as this was not the case in the loin and pelvis at 12 months, the greater increase must have occurred over the summer from 12 - 18 months. This is an expected result, bone being earlier maturing than muscle and the leg joint being earlier maturing than the loin and pelvis. Bone increase was greatest in the pelvis joint and least in the loin, where it was very little more than at 12 months, suggesting that growth of the lumbar vertebrae on a H.P. diet has reached its peak before 12 months of age. Subcutaneous fat increase was equally great in the loin and pelvis but less so in the leg, suggesting that more of this fat was laid down during the summer on the pelvis than it was on the loin with the least deposition on the leg. Intermuscular fat increase was similar in all three joints, that in the pelvis being little more than at 12 months, while the loin showed the greatest increase between 12 and 18 months in this type of fat.

In the M.P. animals during this time the pattern of relative increase in muscle was similar to that described at 12 months, with pelvis muscle showing the greatest increase but very little difference between that of the other two joints, although all had increased considerably relative to 12 months. Bone increase followed the same pattern as in the H.P. animals with the greatest increase occurring in the pelvis and with the loin increase being just less than that of the leg. In both the pelvis and the leg, muscle and bone were similar in relative increase but in the loin, bone did not increase as much as muscle. Subcutaneous fat increase during this time was very considerable in the loin and pelvis, which were similar, but less so in the leg. Most of this increase occurred during the summer, on average the loin and pelvis showing an increase of five times the amount present at 12 months, while the leg only showed an increase of twice this amount. Intermuscular fat increase was less than that of subcutaneous fat, being greatest in the pelvis and least in the leg, where the increase over the summer was very much smaller than in the other two joints.

In the L.P./Hill animals during this time, as in the other treatments, the greatest increase in muscle was shown by the pelvis, with the least increase in the leg, although it was very little less than that in the loin. Bone increase was also greatest in the pelvis and differed very little in the loin and leg. In the leg, both bone and muscle increased to a similar extent but in the other two joints bone did not increase as much as muscle. Subcutaneous fat increase was very considerable, particularly in the loin, where the increase on average was as great as in the M.P. animals, largely due to the one excessively fat animal mentioned previously. The smallest increase was in the leg. Intermuscular fat tended to increase more in the pelvis than in the leg, with one large exception, which reduced the average for the pelvis and raised the average for the leg. The smallest increase, however, was in the loin, although even here the variations mentioned above make comparisons of doubtful value.

5. Weights of individual bones dissected. The actual weights of the individual bones dissected at each of the three ages are shown in Tables 48 and 48a. Also shown is the weight of each bone in the H.P. and M.P. animals

Table 48

Actual weights of individual bones dissected from animals born in 1956; with H.P. and M.P. expressed as a percentage of L.P. and 50 and 81 weeks as a percentage of 29 weeks. (Weights in gms.)

S.C.C.

Age	Treatment		Vertebrae. Lumbar	Vertebrae. Sacral	Pelvis	Femur*	Tibia*	Patella*	Tarsals*ϕ	Cannon≠
29 weeks	Pre-treatment+		104≢	41	101	78	63	3.4	22.4	27.5
	Wt.	H.P.	160	58	159	112	89	4.4	32.2	36.0
		M.P.	132	44	135	109	83	4.8	29.8	33.8
		L.P.	122	50	119	93	71	5.4	23.4	29.2
50 weeks	% of L.P.	H.P.	131	116	135	120	125	82	138	123
		M.P.	108	88	114	117	116	89	127	116
	% of 29 week weight	H.P.	154	143	158	143	142	129	144	131
		M.P.	127	108	134	139	131	141	133	123
		L.P.	117	123	117	119	113	159	105	106
	Wt.	H.P.	160	60	185	128	104	5.9	35.5	41.6
		M.P.	157	60	167	115	94	5.0	31.1	37.4
		L.P.	139	55	149	107	89	5.8	33.4	38.5
81 weeks	% of L.P.	H.P.	115	109	124	121	117	102	106	108
		M.P.	113	109	112	108	106	86	93	97
	% of 29 week weight	H.P.	154	147	183	164	165	174	159	151
		M.P.	151	147	165	147	149	147	139	136
		L.P.	134	136	148	136	141	171	149	140

* Mean of both legs
ϕ Not weighed individually.
≠ Mean of 4.
\+ Mean of two animals.
≢ 6 vertebrae weight.

Table 48 (contd.)

Actual weights of individual bones dissected from animals born 1956; with H.P. and M.P. expressed as a percentage of L.P. and 50 and 81 weeks as a percentage of 29 weeks. (Weights in gms.).

N.C.C.

Age	Treatment		Vertebrae Lumbar	Vertebrae Sacral	Pelvis	Femur*	Tibia*	Patella*	Tarsals*∅	Cannon≠
29 weeks	Pre-treatment+		120≢	39	119	88	76	4.2	24.7	30.7
	Wt.	H.P.	159	63	154	118	94	5.9	32.2	39.1
		M.P.	138	53	139	117	89	6.2	31.1	34.8
		L.P.	122	45	111	99	79	4.7	28.1	33.1
50 weeks	% of L.P.	H.P.	131	140	138	120	119	126	115	118
		M.P.	113	118	125	119	113	132	111	105
	% of 29 week weight	H.P.	132	163	130	134	124	141	130	127
		M.P.	115	137	117	133	118	148	126	113
		L.P.	102	116	94	112	105	112	114	108
	Wt.	H.P.	184	71	207	139	113	6.6	32.2	43.1
		M.P.	175	61	192	127	108	5.9	34.1	40.8
		L.P.	139	54	151	116	95	5.6	30.1	39.1
81 weeks	% of L.P.	H.P.	133	132	137	120	119	118	107	110
		M.P.	126	113	127	109	114	105	113	104
	% of 29 week weight	H.P.	153	184	175	158	148	157	130	140
		M.P.	146	157	162	144	143	141	138	133
		L.P.	116	140	127	132	125	133	122	127

* Mean of both legs.
∅ Not weighed individually.
≠ Mean of 4.
\+ Mean of two animals.
≢ 6 vertebrae weight.

Table 48a

Actual weights of individual bones dissected from animals born 1957; with H.P. and M.P. expressed as a percentage of Hill and 50 and 80 weeks as a percentage of 24 weeks. (Weights in gms.)

S.C.C.

Age	Treatment		Vertebrae Lumbar	Vertebrae Sacral	Pelvis	Femur*	Tibia*	Patella*	Tarsals*ø	Cannon≠
24 weeks	Pre-treatment+		109	36	100	81	65	3.5	23.8	27.0
50 weeks	Wt.	H.P.	161	49	131	95	81	5.4	26.3	32.5
		M.P.	117	41	130	97	76	3.5	24.5	28.7
		Hill	117	47	116	95	77	4.5	25.3	30.0
	% of Hill	H.P.	138	104	113	100	105	120	104	108
		M.P.	100	87	112	102	99	78	97	96
	% of 24 week weight	H.P.	148	136	131	117	125	154	111	120
		M.P.	107	114	130	120	117	100	103	106
		Hill	107	131	116	117	118	129	106	111
80 weeks	Wt.	H.P.	152	60	157	119	96	5.5	31.5	34.4
		M.P.	154	72	171	112	89	4.8	30.3	35.9
		Hill	146	55	153	105	85	5.0	27.8	35.4
	% of Hill	H.P.	104	109	103	113	113	110	113	97
		M.P.	105	131	112	107	105	96	109	101
	% of 24 week weight	H.P.	139	167	157	147	148	157	132	127
		M.P.	141	200	171	138	137	137	127	133
		Hill	134	153	153	130	131	143	117	131

* Mean of both legs.
ø Not weighed individually.
≠ Mean of 4.
+ Mean of two animals.

Table 48a (contd.)

Actual weights of individual bones dissected from animals born 1957; with H.P. and M.P. expressed as a percentage of Hill and 50 and 80 weeks as a percentage of 24 weeks. (Weights in gms.).

N.C.C.

Age	Treatment		Vertebrae Lumbar	Vertebrae Sacral	Pelvis	Femur*	Tibia*	Patella*	Tarsals*ø	Cannon≠
24 weeks	Pre-treatment+		128	45	122	98	80	4.2	28.0	34.5
	Wt.	H.P.	166	64	158	115	95	5.6	31.4	38.9
		M.P.	125	42	119	107	84	5.1	32.0	33.8
		Hill	115	33	102	90	76	4.4	26.3	30.2
50 weeks	% of Hill	H.P.	144	194	155	128	125	127	119	129
		M.P.	109	127	117	119	111	116	122	112
	% of 24 week weight	H.P.	130	142	130	117	119	133	112	113
		M.P.	98	93	98	109	105	121	114	98
		Hill	90	73	84	92	95	105	94	88
	Wt.	H.P.	182	85	187	139	111	7.0	38.0	42.6
		M.P.	155	65	164	125	100	5.8	34.8	39.6
		Hill	180	57	146	114	95	6.3	35.5	38.0
80 weeks	% of Hill	H.P.	101	149	128	122	117	111	107	112
		M.P.	86	114	112	110	105	92	98	104
	% of 24 week weight	H.P.	142	189	153	142	139	167	136	123
		M.P.	121	144	134	128	125	138	124	115
		Hill	141	127	120	116	119	150	127	110

* Mean of both legs.
ø Not weighed individually.
≠ Mean of 4.
\+ Mean of two animals.

at 12 and 18 months as a percentage of the weight of the same bone in the L.P./Hill animals and in all three treatment animals at the same two ages as a percentage of the weight of the same bone prior to treatment.

At 12 months, between the H.P. and L.P./Hill animals the greatest differences in weight were created in the lumbar and sacral vertebrae and the pelvic bone, referred to from now on as the pelvis. On average, all three showed similar differences but in the sacral vertebrae or sacrum, there was apparently a considerable breed difference, with the N.C.C. animals showing very much greater differences than the S.C.C. animals, due equally to greater weights in the H.P. animals and lighter weights in the L.P./Hill. The cannons, tarsals, femur and tibia all showed similar differences between these treatments, being almost half that shown in the other bones above. This is to be expected in view of the earlier developing nature of the leg bones relative to the pelvis and vertebrae (Hammond, 1932; Palsson and Verges, 1952). The patella also would appear to follow the other leg bones in its relative difference but being small made it very liable to error from the scraping technique, which probably accounts for the great variation that existed.

Between the M.P. and L.P./Hill animals at 12 months the greatest difference in weight was created in the pelvis, closely followed by the femur and tarsals, although there was a great deal of variation in the latter. Next came the tibia, lumbar vertebrae and cannons, while the smallest differences were apparently in the sacrum and patella but in both there was a similar breed difference as discussed above in the former, with here the N.C.C. animals showing considerable increases and the S.C.C. animals decreasing, relative to the L.P./Hill. Over the treatment period in the H.P. animals the greatest increases were made by the sacrum, lumbar vertebrae, patella and pelvis. Intermediate and similar came the femur and tibia, while the smallest increases were made by the patella and cannons. In the M.P. animals, however, while the smallest increase was again made by the cannons, that of the lumbar vertebrae and sacrum was very little more and considerably less than that of the tibia, tarsals and pelvis, which increased less than the femur and patella. This suggests that on a M.P. or maintenance diet at this time the later maturing bones of the leg and the earlier maturing pelvis have a greater potential for growth than the later maturing vertebrae and early maturing cannons and are capable of continuing growth while the others are restricted. On a H.P. diet there was no restriction and the later developing vertebrae were able to grow considerably. In the L.P./Hill animals the cannons made the smallest increase, along with the pelvis, lumbar vertebrae and tarsals, which were very similar. Next came the tibia, followed by the femur and sacrum, while the patella appeared to increase very considerably but this may be due to the error discussed above, although the trend for greater increase seems fairly consistent.

There is apparently a breed difference in the relative increases in weight of the various bones, the S.C.C. animals increasing more than the N.C.C. animals over the treatment period. This is most obvious in the latest developing bones and is greater in the L.P./Hill and M.P. animals than it is in the H.P. animals, where treatment appears to have reduced the difference. Relatively heavier bones prior to treatment in the N.C.C. breed probably account for this but the greater effects of treatment suggest that this breed may be later maturing skeletally than the S.C.C. breed and over the treatment period on a maintenance or restricted diet their potential for growth is less than that of the latter breed.

Between the H.P. and L.P./Hill animals at 18 months the greatest differences were still in the sacrum and pelvis, although smaller than at 12 months, followed by the femur and tibia, which were the same as at 12 months. The lumbar vertebrae difference, however, was much reduced from that at 12 months and less even than the difference in the femur and tibia. The smallest difference was now in the cannons, with the tarsals and patella very little more and all three less than at 12 months. Between the M.P. and L.P./Hill animals at

18 months the greatest differences were in the sacrum and pelvis, the former now being greater than at 12 months in the S.C.C. breed but less in the N.C.C. breed, while the latter remained unchanged from the difference at 12 months. The lumbar vertebrae, femur and tibia all showed similar differences and only in the latter two were they, to a very limited extent, reduced from 12 months. Very small differences remained between these treatments in the tarsals and cannons, while the M.P. patellas now appeared to be lighter than those of the L.P./Hill animals.

From prior to treatment to 18 months in the H.P. animals the greatest increase was made by the sacrum, followed by the pelvis and patella. These were followed by the femur and tibia, which were similar, and the lumbar vertebrae, which were very little less. All bones increased considerably from 12 - 18 months except the latter, which showed only a limited increase during this time. The smallest increase continued to be made by the tarsals and cannons. In the M.P. animals the picture of relative increase was very similar with minor exceptions, namely, that the lumbar vertebrae, patella, femur and tibia all made similar intermediate increases and that all bones increased considerably relative to 12 months. In the L.P./Hill animals the greatest increase was made by the patella, followed by the sacrum and pelvis, the latter two being nearly the same. All the other bones made smaller but very similar increases.

With the cannons being early maturing and making the smallest increase to 12 and 18 months, Table 49 shows the weight of each of the other bones as a percentage of the weight of all four cannons at all three ages. This method, as described by Palsson and Verges (1952), shows the relative changes that occur in the weight of the various bones at 12 and 18 months as affected by treatment. On average, prior to treatment, the lumbar vertebrae were 97%, the sacrum was 34%, the pelvis 93%, the femur 72% and the tibia 59% of the weight of the cannons. At 12 months, post-treatment, in the H.P. animals

Table 49

Weights of individual bones dissected, expressed as a percentage of the total weight of all four cannon bones.

Age	Treatment	Vertebrae Lumbar	Vertebrae Sacral	Pelvis	Femur	Tibia
Born 1956						
S.C.C.						
29 weeks	Pre-treatment+	95	37	92	71	57
50 weeks	H.P.	111	40	110	78	62
	M.P.	98	33	100	81	61
	L.P.	104	43	102	80	61
81 weeks	H.P.	96	36	111	77	63
	M.P.	105	40	112	77	63
	L.P.	90	36	97	69	58
N.C.C.						
29 weeks	Pre-treatment+	98	32	97	72	62
50 weeks	H.P.	102	40	98	75	60
	M.P.	99	38	100	84	64
	L.P.	92	34	84	75	60
81 weeks	H.P.	107	41	120	81	66
	M.P.	107	37	118	78	66
	L.P.	89	35	97	74	61
Born 1957						
S.C.C.						
24 weeks	Pre-treatment+	101	33	93	75	60
50 weeks	H.P.	124	38	101	73	62
	M.P.	102	36	113	84	66
	Hill	98	39	97	79	64
80 weeks	H.P.	110	44	114	86	70
	M.P.	107	50	119	78	62
	Hill	103	39	108	74	60
N.C.C.						
24 weeks	Pre-treatment+	93	33	88	71	58
50 weeks	H.P.	107	41	102	74	61
	M.P.	92	31	88	79	62
	Hill	95	27	84	75	63
80 weeks	H.P.	107	50	110	82	65
	M.P.	98	41	104	79	63
	Hill	118	38	96	75	63

+ Mean of two animals

the greatest increase relative to the cannons was shown by the sacrum, followed by the lumbar vertebrae and pelvis, with averages of 40%, 111% and 103% respectively, while the femur and tibia only gained very slightly, being now 75% and 61% respectively. In the M.P. animals the femur appears to have made the greatest relative increase, averaging 82%, followed by the pelvis, 100%, and the tibia, 63%. Both the lumbar vertebrae and the sacrum remained relatively the same as the cannons, averaging 98% and 35%. In the L.P./Hill animals there was very little difference in the weights of the bones relative to cannon weight from that present prior to treatment, only the femur, sacrum and tibia appearing to increase very slightly, averaging 77%, 36% and 62% respectively, while the lumbar vertebrae and pelvis averaged 97% and 92%.

At 18 months in the H.P. animals all bones had increased relative to the cannons, the sacrum and pelvis to the greatest extent, averaging now 43% and 114% respectively of the cannon weight, while the femur and tibia averaged 82% and 66% respectively and the lumbar vertebrae only 105%. In the M.P. animals the picture was very similar, with the sacrum, pelvis and lumbar vertebrae gaining almost as much relative to the cannons as in the H.P. animals and averaging 42%, 113% and 104% respectively. The femur and tibia, however, gained less relative to the cannons than in the H.P. animals, averaging only 78% and 64% respectively. In the L.P./Hill animals only the sacrum and pelvis increased to any considerable extent relative to the cannons but very much less than in the other two treatments, averaging 37% and 100% respectively. The other three bones increased very little more than the cannons, averaging 100%, 73% and 61% for the lumbar vertebrae, femur and tibia respectively.

6. Relative development of certain joints and tissues. In Tables 50 and 50a the weights of muscle and total fat in the various joints and the total hindquarters are shown as percentages of the weight of bone in the respective joints at all three ages. Prior to treatment the loin contained on average 7.5 times more muscle and 2.6 times more fat, the pelvis 5.4 times more muscle

Table 50

Weights of muscle and total fat in the hindquarter joints of animals born 1956 expressed as a percentage of the weight of bone in the respective joints.

			Born 1956			
			S.C.C.		N.C.C.	
Age	Treatment	Joint	Muscle	Total fat	Muscle	Total fat
29 weeks	Pre-treatment+	Loin	765	270	772	278
		Pelvis	552	232	540	245
		Leg*	663	123	642	110
		Total h-quarters	656	177	644	174
50 weeks	H.P.	Loin	754	160	739	165
		Pelvis	492	155	580	192
		Leg*	658	116	645	104
		Total h-quarters	633	134	647	136
	M.P.	Loin	674	117	794	124
		Pelvis	472	115	513	130
		Leg*	504	94	555	99
		Total h-quarters	526	103	586	110
	L.P.	Loin	564	35	640	118
		Pelvis	454	98	498	112
		Leg*	491	61	494	73
		Total h-quarters	495	65	521	90
81 weeks	H.P.	Loin	790	309	796	410
		Pelvis	520	241	577	312
		Leg*	622	149	657	137
		Total h-quarters	625	199	661	232
	M.P.	Loin	828	285	749	325
		Pelvis	534	270	556	264
		Leg*	647	128	630	111
		Total h-quarters	650	193	632	188
	L.P.	Loin	880	244	831	515
		Pelvis	575	215	547	340
		Leg*	650	112	592	158
		Total h-quarters	670	160	621	261

+ Mean of two animals.
* Mean of two legs/animal.

Table 50a

Weights of muscle and total fat in the hindquarter joints of animals born 1957 expressed as a percentage of the weight of bone in the respective joints.

			Born 1957			
			S.C.C.		N.C.C.	
Age	Treatment	Joint	Muscle	Total fat	Muscle	Total fat
24 weeks	Pre-treatment+	Loin	742	268	738	204
		Pelvis	510	266	556	174
		Leg*	589	118	566	109
		Total h-quarters	600	180	595	141
50 weeks	H.P.	Loin	752	320	782	393
		Pelvis	564	295	529	332
		Leg*	643	143	638	159
		Total h-quarters	647	216	638	246
	M.P.	Loin	768	174	726	144
		Pelvis	465	151	578	148
		Leg*	545	80	516	77
		Total h-quarters	563	113	566	104
	Hill	Loin	688	89	675	100
		Pelvis	441	96	576	96
		Leg*	487	54	528	58
		Total h-quarters	511	70	565	74
80 weeks	H.P.	Loin	916	438	854	338
		Pelvis	602	316	600	248
		Leg*	640	122	633	114
		Total h-quarters	679	225	663	188
	M.P.	Loin	813	342	931	465
		Pelvis	487	265	620	335
		Leg*	603	113	622	132
		Total h-quarters	609	196	674	239
	Hill	Loin	818	296	726	322
		Pelvis	544	252	624	270
		Leg*	596	105	596	125
		Total h-quarters	624	178	629	198

+ Mean of two animals.
* Mean of two legs/animal.

and 2.3 times more fat and the leg 6.1 times more muscle and 1.1 times more fat than bone, causing the total hindquarters to contain 6.2 times more muscle and 1.7 times more fat. At 12 months, post-treatment, in the H.P. animals, the loin and pelvis contained on average the same proportions of the tissues as were present prior to treatment. The leg, however, contained more muscle and fat relative to bone than was the case at that time, averaging 6.5 times and 1.3 times respectively. This resulted in the total hindquarters containing slightly more of both tissues, averaging 6.4 times and 1.8 times the weight of bone respectively. In the M.P. animals the loin averaged almost as much muscle relative to bone as in the H.P. animals and prior to treatment, 7.4 times, but very much less fat, averaging only 1.4 times. The pelvis contained relatively less of both tissues than in the H.P. animals and prior to treatment, averaging 5.1 times for muscle and 1.4 times for fat, while the leg contained less even than was present prior to treatment, averaging only 5.3 times and 0.9 times the weight of bone for muscle and fat respectively. This resulted in the total hindquarters containing on average only 5.6 times more muscle and 1.1 times more fat than bone. In the L.P./Hill animals all three joints contained less muscle and fat relative to bone than in either of the other treatments or prior to treatment. The loin in particular contained very much less muscle and fat, averaging 6.4 times and 0.9 times the weight of bone. The pelvis showed the smallest drop in muscle, containing on average 4.9 times more than bone but fat had dropped to the same weight as bone, while in the leg, muscle had dropped to an average of only 5.0 times and fat to 0.6 times the weight of bone. This resulted in the total hindquarters on average containing muscle only 5.2 times and fat 0.75 times the weight of bone.

At 18 months, in the H.P. animals, the loin contained very much more muscle and fat relative to bone than was the case at 12 months, averaging 8.4 times and 3.7 times respectively. The pelvis contained a limited amount more of both tissues, muscle averaging 5.7 times and fat 2.8 times the weight of bone but the leg on average contained similar weights of both tissues relative to bone as were present at 12 months, namely 6.4 times and 1.3 times for muscle and fat respectively. As a result the total hindquarters contained slightly more than at 12 months of both muscle and fat relative to bone, averaging 6.6 times and 2.1 times the weight of the latter respectively. In the M.P. animals, the picture was very similar to that of the H.P. animals in all joints, with both tissues generally being only very slightly lighter relative to bone than was the case in the above treatment, the loin containing on average 8.3 times more muscle and 3.5 times more fat, the pelvis 5.4 times more muscle and 2.8 times more fat and the leg 6.3 times more muscle and 1.2 times more fat than bone. The difference between the H.P. and M.P. animals in the leg at 12 months had virtually disappeared by 18 months. The total hindquarters therefore contained only slightly less muscle and fat relative to bone than was present in the H.P. animals at this time and very similar to that present in the H.P. animals at 12 months but in different proportions in the constituent joints, the totals averaging 6.4 times and 2.0 times the weight of bone for muscle and fat respectively. In the L.P./Hill animals, the picture was again very similar, particularly to that of the M.P. animals, from which the former only differed very slightly in a few cases, the loin containing on average 8.1 times more muscle and 3.4 times more fat, the pelvis 5.7 times more muscle and 2.7 times more fat and the leg 6.1 times more muscle and 1.2 times more fat than bone. This on average made the total muscle and fat in the hindquarters 6.3 times and 2.0 times heavier respectively than bone, which was very nearly the same as in the M.P. animals and shows the very great increase in both muscle and fat relative to bone from 12 - 18 months after this retarding treatment.

In sub-section 3 above, Tables 43 and 43a showed the proportions of the various joints, including the fore-end, in the total carcass and while the effects of treatment on the fore-end relative to the whole were examined, the ratio of the total hindquarters to the forequarters uncomplicated by the head and feet was not considered at that time. This is now shown in Table 51 along with the ratios in the hindquarters of muscle to intermuscular fat and subcutaneous fat to total fat. Prior to treatment the hindquarters averaged 88% of the weight of the forequarters. In the H.P. animals at 12 months this had dropped to an average of 84%, showing that while H.P. rearing has created a considerable increase in the joints and tissues of the hindquarters, this was relatively less than occurred in the forequarters, where growth must have been very considerable indeed. In both the M.P. and L.P./Hill animals the hindquarters were very little less relative to the forequarters than was the case prior to treatment, averaging 87%. At 18 months in the H.P. animals, the figure had dropped to an average of 81% and was still less than that of both the M.P. and L.P./Hill animals which had dropped to an average of 83%, suggesting that only the H.P. treatment has succeeded in creating any persistent difference in the relative development of the fore and hind quarters.

Intermuscular fat is apparently related to some extent to the quantity of muscle present, showing very much less variation with treatment than subcutaneous fat. Table 51 shows that although there is a great deal of individual variation, on average prior to treatment there was 8.2 times more muscle than intermuscular fat in the hindquarters. In the H.P. animals at 12 months this had increased very slightly to an average of 8.4 times, while in the M.P. animals it had gone up to 9.0 times and in the L.P./Hill animals to 10.7 times. It is not inconceivable that there may be an upper limit of intermuscular fat deposition relative to muscle and treatment, while it may reduce the amount of fat present, is possibly incapable of raising the quantity beyond the optimum upper limit. The powers of recovery in terms of intermuscular fat appear to be very rapid over the period from 12 - 18 months, both the H.P. and L.P./Hill animals containing at the latter age an average of 8.1 times more muscle than intermuscular fat, although the M.P. animals appear to be relatively fatter, averaging only 7.5 times more muscle.

Table 51

Relative development of certain joints and tissues dissected from animals born 1956 and 1957.

Age	Treatment	$\frac{\text{Hindquarters}}{\text{Forequarters}} \times 100$	$\frac{\text{Muscle}}{\text{Intermuscular Fat}} \times 100$	$\frac{\text{Subcutaneous fat}}{\text{Total fat}} \times 100$
		Born 1956		
		S.C.C.		
29 weeks	Pre-treatment	90	843	56
50 weeks	(H.P.	85	1140	59
	(M.P.	85	887	42
	(L.P.	87	1309	42
81 weeks	(H.P.	77	927	66
	(M.P.	84	817	59
	(L.P.	88	889	53
		N.C.C.		
29 weeks	Pre-treatment	91	855	57
50 weeks	(H.P.	89	971	51
	(M.P.	88	1074	51
	(L.P.	81	897	35
81 weeks	(H.P.	81	647	56
	(M.P.	79	781	57
	(L.P.	81	719	67
		Born 1957		
		S.C.C.		
24 weeks	Pre-treatment	83	688	52
50 weeks	(H.P.	80	592	49
	(M.P.	85	760	35
	(Hill	88	1011	27
80 weeks	(H.P.	83	768	61
	(M.P.	83	697	55
	(Hill	80	799	56
		N.C.C.		
24 weeks	Pre-treatment	87	915	54
50 weeks	(H.P.	82	670	61
	(M.P.	89	861	37
	(Hill	93	1041	26
80 weeks	(H.P.	84	898	61
	(M.P.	86	685	59
	(Hill	84	828	62

With subcutaneous fat being affected by treatment to a greater extent than intermuscular fat, Table 51 shows the percentage of the former in the total tissue fat of the hindquarters excluding the tail. Prior to treatment, subcutaneous fat on average constituted 55% of the total. At 12 months in the H.P. animals it still averaged 55% but in the M.P. animals it had dropped to 41% and in the L.P./Hill animals it was only 33%. At 18 months it was very similar in all treatments, averaging 61%, 58% and 60% for the H.P., M.P. and L.P./Hill animals respectively. Subcutaneous fat being the latest developing tissue of the body accounts for these greater percentages at this time than at the earlier ages, particularly as "condition" is largely the deposition of this external fat layer.

7. Bone measurements. As the weight of a bone does not by itself give any information on its shape as affected by treatment, most bones dissected were photographed against a centimetre squared background and were also measured. The bones photographed were the lumbar vertebrae, the sixth rib, the pelvis, the femur and tibia, both right and left, and all four cannon bones from all animals dissected. These are shown for the 1956 born animals, pre-treatment in Plates 13 and 13A, post-treatment at 50 weeks in Plates 14 and 14A and at 81 weeks in Plates 15, 15A and 15B. The bones from the 1957 born animals are also shown, pre-treatment in Plates 16 and 16A, post-treatment at 50 weeks in Plates 17, 17A and 17B and at 80 weeks in Plates 18, 18A and 18B. In both years at 12 and 18 months each bone is shown in each breed with the three treatments together for comparative purposes.

The changes of shape with age as affected by treatment are also demonstrated photographically, the pelvic bones in Plates 19, 20, 21 and 22, and the limb bones, i.e. cannon, tibia and femur, in Plates 23, 24, 25 and 26.

It is not proposed to comment specifically on the above photographic representations as they are intended merely as illustrations of the changes in shape described by measurements taken on the actual bones and discussed as follows.

In Table 52 the actual mean length and minimum circumference of the four cannon bones are shown along with the ratios of weight to length and hind cannon length to fore cannon length. While the weight as a percentage of length is not a very accurate measure of growth in thickness owing to differential development of the shaft and the epiphyses with treatment and age, it does nevertheless provide some information on the growth of the latter which is not described by the minimum circumference measurement. Prior to treatment the average figure was 27.9. In the H.P. animals at 12 months it had gone up to 31.6, indicating a greater increase in density and thickness relative to length from this treatment. In the M.P. animals the figure was 29.6, showing a similar but smaller trend to that above, while in the L.P./Hill animals the figure was virtually unchanged from that prior to treatment, averaging 28.0. The early development of this bone enables it to increase relatively more in thickness than in length on a H.P. diet but is restricted by a L.P./Hill diet from increasing any more in the later developing thickness than in the earlier developing length. At 18 months the figure had gone up to an average of 34.5 in the H.P. animals, 33.5 in the M.P. and 32.0 in the L.P./Hill. Growth in thickness had obviously increased relative to length in all treatments but still more so in the H.P. and M.P. animals than in the L.P./Hill, which, while they may have been as long or even longer than the others, were thinner in the shaft and lighter in the extremities.

Prior to treatment the hind cannons were 3% longer on average than the fore cannons. At 12 months in the H.P. animals the hind cannons had increased their advantage to 5% but in the other treatments the difference remained at 3%. This indicates that at this time the hind cannons had a greater potential for length growth than the fore cannons which was realised on a H.P. diet. However, it appears that there is no permanence in this as by 18 months all three

Table 52

Measurements of cannon bones dissected from animals born 1956 and 1957 (mms.)
Mean of four cannons per animal.

Age	Treatment	Length	Minimum circumference	Wt./length x 100	Hind length*/Fore length x 100
		Born 1956			
		S.C.C.			
29 weeks	Pre-treatment+	105.3	42.5	26.2	103
50 weeks	H.P.	111.0	46.0	32.4	106
	M.P.	107.8	45.8	31.3	104
	L.P.	103.5	43.0	28.2	103
81 weeks	H.P.	116.3	47.5	35.9	104
	M.P.	114.8	46.5	32.7	101
	L.P.	116.0	46.1	33.2	105
		N.C.C.			
29 weeks	Pre-treatment+	109.3	43.5	28.1	102
50 weeks	H.P.	119.1	46.0	32.8	104
	M.P.	113.8	44.0	30.6	102
	L.P.	116.4	42.3	28.4	104
81 weeks	H.P.	124.0	47.8	34.8	102
	M.P.	114.6	48.3	35.5	102
	L.P.	125.6	44.6	31.1	102
		Born 1957			
		S.C.C.			
24 weeks	Pre-treatment+	100.0	41.2	27.0	103
50 weeks	H.P.	113.2	40.5	28.8	107
	M.P.	105.8	41.9	27.2	101
	Hill	104.1	41.8	28.8	101
80 weeks	H.P.	108.5	44.5	31.8	101
	M.P.	110.6	43.8	32.5	107
	Hill	113.2	45.0	31.3	103
		N.C.C.			
24 weeks	Pre-treatment+	114.5	43.5	30.2	105
50 weeks	H.P.	120.6	45.5	32.3	104
	M.P.	115.9	42.8	29.2	104
	Hill	113.2	42.2	26.6	102
80 weeks	H.P.	120.5	48.0	35.4	103
	M.P.	119.0	46.0	33.3	102
	Hill	118.0	43.5	32.2	103

* Mean of right and left cannons per animal.
\+ Mean of two animals.

treatments showed on average the same 3% difference.

In Table 53 the mean length and minimum circumference of the four cannons in the H.P. and M.P. animals at 12 and 18 months are shown as percentages of the same measurements in the L.P./Hill animals and in all three treatment animals at the same two ages as percentages of the same measurements prior to treatment. At 12 months between the H.P. and L.P./Hill animals there was an average difference of 6% in length and 5% in circumference, suggesting that both measurements were nearly equally affected by treatment. Between the M.P. and L.P./Hill animals there was an average difference of 2% in length and 3% in circumference, duplicating the above picture on a smaller scale. In general, treatment had very little effect on growth in the cannon, probably due to its very early development, having passed its stage of maximum growth when treatment was applied.

Over the treatment period in the H.P. animals, length increased on average by 8% and circumference by only 4%. In the M.P. animals the increases averaged 3% and 2% respectively, while in the L.P./Hill animals length increased on average by 2% while circumference remained unchanged. This indicates that during this time length growth still has a higher potential than thickness growth and will continue on a diet which prohibits the latter.

At 18 months between the H.P. and L.P./Hill animals there was on average no difference in length but 5% difference in circumference, while between the M.P. and L.P./Hill animals the former now appeared to be slightly shorter on average but still 3% thicker. From prior to treatment to 18 months in the H.P. animals, length increased on average by 9%, very little growth occurring over the summer from 12 - 18 months, while circumference increased on average by 10%, a considerable increase occurring over the summer. In the M.P. animals, both measurements increased, on average by 7% in length and 8% in circumference, with more increase in thickness than length over the summer. In the L.P./Hill animals, length increased by an average of 10% while circumference increased

Table 53

Measurements of cannon bones dissected from animals born 1956 and 1957;
H.P. and M.P. expressed as a percentage of L.P. or Hill
and 50 and 81 or 80 weeks as a percentage of 29 or 24 weeks.
Mean of four cannons per animal.

			S.C.C.		N.C.C.	
			Length	Minimum circumference	Length	Minimum circumference
Born 1956						
50 weeks	% of L.P.	H.P.	107	107	102	109
		M.P.	104	106	98	104
	% of 29 week measurement	H.P.	105	108	109	106
		M.P.	102	108	104	101
		L.P.	98	101	106	97
81 weeks	% of L.P.	H.P.	100	103	99	107
		M.P.	99	101	91	108
	% of 29 week measurement	H.P.	110	112	113	110
		M.P.	109	109	105	111
		L.P.	110	108	115	102
Born 1957						
50 weeks	% of Hill	H.P.	109	97	107	108
		M.P.	102	100	102	101
	% of 24 week measurement	H.P.	113	98	105	105
		M.P.	106	102	101	98
		Hill	104	100	99	97
80 weeks	% of Hill	H.P.	96	99	102	110
		M.P.	98	97	101	106
	% of 24 week measurement	H.P.	109	108	105	110
		M.P.	111	106	104	106
		Hill	113	109	103	100

by only 5%, all of the latter and most of the former occurring over the summer.

In Tables 54 and 54a are shown the length and minimum circumference of the tibia and femur and the length and "spring" of the sixth rib. Also shown is the product of these two rib measurements as a guide to the shape of the rib (Hammond, 1932). In Tables 55 and 55a all these measurements in the H.P. and M.P. animals at 12 and 18 months are shown as percentages of the same measurements in the L.P./Hill animals and in all three treatment animals at the same two ages as percentages of the same measurements prior to treatment. At 12 months in the two long bones of the leg, between the H.P. and L.P./Hill animals there was on average a difference of 4% in length but in circumference the difference averaged 7% in the tibia and 5% in the femur. Between the M.P. and L.P./Hill animals there was on average a difference of 3% in both measurements in the tibia and 4% in both measurements in the femur. Treatment therefore appears to have had more effect on thickness growth than length growth and on the tibia more than the femur at the time the treatments were applied. At 12 months in the sixth rib, between the H.P. and L.P./Hill animals there was on average a difference of 9% in length, 14% in "spring" and 24% in their product. Between the M.P. and L.P./Hill animals the differences averaged 2%, 7% and 9% respectively. Treatment has obviously had a considerable effect on the development of the ribs, particularly on "spring", indicating a relatively flat sided narrow chest resulting from L.P./Hill wintering and a broader, deeper chest from H.P. wintering.

Over the treatment period in the H.P. animals there was very little difference between the long bones in length increase, the tibia increasing on average by 8% and the femur by 7%. In circumference, however, the former increased by only 6% while the latter increased by 11%. In the M.P. animals the picture was similar, with length increase averaging 6% and 7% for tibia and femur respectively, while circumference increase averaged 3% and 9% respectively. In the L.P./Hill animals the tibia increased in length by an average of 4%

Table 54

Measurements of tibias, femurs and sixth ribs dissected from animals born 1956 (mms.)

Born 1956

Age	Treatment	Tibia* Length	Tibia* Minimum circumference	Femur* Length	Femur* Minimum circumference	6th Rib Length	6th Rib Spring	6th Rib Length x Spring
S.C.C.								
29 weeks	Pre-treatment+	165.0	43.5	143.2	51.0	148	41	6068
50 weeks	H.P.	182.0	48.0	157.0	59.5	159	49	7791
	M.P.	178.0	47.0	156.0	60.5	145	47	6815
	L.P.	168.0	43.0	147.5	54.0	146	39	5694
81 weeks	H.P.	189.0	51.0	165.0	63.5	179	50	8950
	M.P.	188.0	49.0	163.0	59.0	170	49	8330
	L.P.	184.0	49.5	157.0	55.5	154	52	8008
N.C.C.								
29 weeks	Pre-treatment+	177.2	46.5	151.0	55.5	147	43	6321
50 weeks	H.P.	189.5	49.0	164.5	59.0	165	46	7590
	M.P.	184.0	46.0	161.0	57.0	161	41	6601
	L.P.	181.5	45.0	151.0	57.0	152	44	6688
81 weeks	H.P.	207.0	52.0	176.0	65.0	175	55	9625
	M.P.	196.5	53.0	165.0	63.0	169	54	9126
	L.P.	202.0	47.5	172.5	57.5	181	52	9412

* Mean of two legs/animal.
\+ Mean of two animals.

Table 54a

Measurements of tibias, femurs and sixth ribs dissected from animals born 1957 (mms.)

Born 1957

Age	Treatment	Tibia* Length	Tibia* Minimum circumference	Femur* Length	Femur* Minimum circumference	6th Rib Length	6th Rib Spring	6th Rib Length x Spring
S.C.C.								
24 weeks	Pre-treatment+	162.0	42.0	142.0	52.5	141	38	5458
50 weeks	H.P.	173.5	44.0	147.0	56.0	161	43	6923
	M.P.	174.5	45.0	152.5	57.5	150	45	6750
	Hill	173.0	45.5	150.5	57.0	152	42	6384
80 weeks	H.P.	189.5	49.0	166.0	63.5	171	53	9063
	M.P.	178.5	48.0	154.0	59.5	167	46	7682
	Hill	179.5	47.0	157.0	58.5	162	50	8100
N.C.C.								
24 weeks	Pre-treatment+	176.0	46.0	150.7	53.7	153	41	6173
50 weeks	H.P.	189.0	48.0	159.5	60.0	173	47	8131
	M.P.	183.0	45.0	157.5	55.0	160	41	6560
	Hill	182.0	44.0	153.0	54.5	156	38	5928
80 weeks	H.P.	202.0	52.0	174.5	65.0	173	48	8304
	M.P.	198.0	50.0	169.0	61.0	180	47	8460
	Hill	189.5	48.0	158.5	58.0	172	48	8256

* Mean of two legs/animal.
+ Mean of two animals.

Table 55

Measurements of tibias, femurs and sixth ribs dissected from animals born 1956; H.P. and M.P. expressed as a percentage of L.P. and 50 and 81 weeks as a percentage of 29 weeks.

Born 1956

			Tibia*		Femur*		6th Rib		
			Length	Minimum circumference	Length	Minimum circumference	Length	Spring	Length x Spring
S.C.C.									
50 weeks	% of L.P.	H.P.	109	112	106	110	109	126	137
		M.P.	106	109	106	112	99	120	120
	% of 29 week measurement	H.P.	110	110	109	117	107	121	130
		M.P.	108	108	109	119	98	116	114
		L.P.	102	99	103	106	99	96	95
81 weeks	% of L.P.	H.P.	103	102	105	114	116	96	112
		M.P.	102	99	104	106	110	94	104
	% of 29 week measurement	H.P.	115	117	115	124	121	124	149
		M.P.	114	113	114	116	115	121	139
		L.P.	111	114	110	109	104	128	134
N.C.C.									
50 weeks	% of L.P.	H.P.	104	109	109	103	109	105	114
		M.P.	102	102	107	100	106	93	99
	% of 29 week measurement	H.P.	107	105	109	106	112	107	120
		M.P.	104	99	107	103	109	95	104
		L.P.	102	97	100	103	103	102	106
81 weeks	% of L.P.	H.P.	103	109	102	113	97	106	102
		M.P.	97	111	96	110	93	104	97
	% of 29 week measurement	H.P.	117	112	117	118	119	128	152
		M.P.	111	114	109	114	115	126	145
		L.P.	114	103	114	104	123	121	149

* Mean of two legs/animal.

Table 55a

Measurements of tibias, femurs and sixth ribs dissected from animals born 1957; H.P. and M.P. expressed as a percentage of Hill and 50 and 80 weeks as a percentage of 24 weeks.

Born 1957

			Tibia* Length	Tibia* Minimum circumference	Femur* Length	Femur* Minimum circumference	6th Rib Length	6th Rib Spring	6th Rib Length x Spring
S.C.C.									
50 weeks	% of Hill	H.P.	100	97	98	98	106	102	108
		M.P.	101	99	101	101	99	107	106
	% of 24 week measurement	H.P.	107	105	104	107	114	113	127
		M.P.	108	107	107	110	106	118	124
		Hill	107	108	106	109	108	111	117
80 weeks	% of Hill	H.P.	106	104	106	109	106	106	112
		M.P.	99	102	98	102	103	92	95
	% of 24 week measurement	H.P.	117	117	117	121	121	139	166
		M.P.	110	114	108	113	118	121	141
		Hill	111	112	111	111	115	132	149
N.C.C.									
50 weeks	% of Hill	H.P.	104	109	104	110	111	124	137
		M.P.	101	102	103	101	103	108	111
	% of 24 week measurement	H.P.	107	104	106	112	113	115	131
		M.P.	104	98	105	102	105	100	106
		Hill	103	96	102	101	102	93	96
80 weeks	% of Hill	H.P.	107	108	110	112	101	100	100
		M.P.	104	104	107	105	105	98	102
	% of 24 week measurement	H.P.	115	113	116	121	113	117	134
		M.P.	112	109	112	114	118	115	137
		Hill	108	104	105	108	112	117	133

* Mean of two legs/animal.

and the femur by 3%, while in circumference the former remained unchanged and the latter increased by 5%. The later developing femur has obviously a greater potential for thickness growth at this time than the earlier developing tibia and is therefore less affected by treatment in this respect. Over the treatment period in the H.P. animals the sixth rib increased by an average of 12% in length and 14% in "spring", giving an increase of 27% in their product. In the M.P. animals the respective average increases were 5%, 7% and 12%, while in the L.P./Hill animals length increased by 3% but "spring" tended to remain unchanged, giving an average increase of only 4% in their product.

At 18 months in the long bones, between the H.P. and L.P./Hill animals there was an average difference in length of 5% in the tibia and 6% in the femur, while in circumference there was an average difference of 6% in the former but 12% in the latter. This indicates that while treatment had less effect on thickness growth in the femur than in the tibia at 12 months, the greater potential inherent in the former subsequent to this time superimposed on treatment has resulted in a much greater difference in circumference between these treatments at 18 months in this bone than in the earlier developing tibia. Between the M.P. and L.P./Hill animals the differences in length were very small in both bones, averaging 1% and 2% in the tibia and femur respectively, while in circumference the differences were greater in both bones but very similar in magnitude, averaging 5% and 4% respectively, the effects of treatment being no greater on the femur than on the tibia in this case. At 18 months in the sixth rib, between the H.P. and L.P./Hill animals there was now less difference in "spring" than in length, averaging 2% and 5% respectively, with their product averaging 7% in difference. Between the M.P. and L.P./Hill animals the differences had practically disappeared, length averaging 2% more but [redacted] "spring" 3% less in the M.P. animals, with a product of 2% less.

From prior to treatment to 18 months in the H.P. animals both long bones increased by an average of 16% and while the tibia circumference showed a similar increase of 15% that of the femur was much greater, averaging 21%. In the M.P. animals there was very little difference between the bones, length increasing on average by 12% and 11% in the tibia and femur respectively, while circumference increased by 13% and 14% respectively, the latter measurement showing a slightly greater increase relative to length in the femur than in the tibia, duplicating on a smaller scale the H.P. picture. In the L.P./Hill animals there was virtually no difference between the bones, length increasing on average by 11% and 10% in the tibia and femur respectively, while circumference increased by only 8% in both bones. Treatment has obviously had more persistent effect on the development of the later maturing femur than on the earlier maturing tibia in thickness growth only, length growth appearing to respond similarly in both bones. From prior to treatment to 18 months in the H.P. animals the sixth rib increased in length on average by 19%, while "spring" increased by 27%, giving an increase of 50% in their product. In the M.P. animals length increased by an average of 17%, "spring" by an average of 21% and their product by an average of 41%. In the L.P./Hill animals the respective average increases were 14%, 25% and 41%. The ribs being late developing bones enabled the retardation that occurred on L.P./Hill wintering to be largely overcome during the period 12 - 18 months, particularly in the "spring" measurement, while the shape index as shown by the product of the two measurements was still greater in the H.P. animals but similar in the M.P. and L.P./Hill animals.

With the pelvis being one of the latest developing bones in the body and one whose development may have considerable importance on the ease of lambing and reduction of difficult births, particularly in the first lamb crop, a series of measurements were taken on the dissected pelvic bones, Bassett (1955) having shown that there is no close relationship between external live measurements and internal bone measurements. The five actual measurements taken are shown in Table 56, while in Tables 57 and 57a each measurement in the H.P. and M.P. animals at 12 and 18 months is shown as a percentage of the same measurement

Table 56

Measurements of pelvic bones dissected from animals born 1956 and 1957 (mms.)

Born 1956

S.C.C.

Age	Treatment	Length*	Width at hips	Width at pins	Width at femur-acetabulum	Internal width
29 weeks	Pre-treatment+	162.5	132.0	93.0	91.5	66.5
50 weeks	(H.P.	180.5	147	115	105	73.8
	(M.P.	172.0	142	106	102	73.8
	(L.P.	168.0	137	101	101	73.0
81 weeks	(H.P.	198.5	170	122	112	85.3
	(M.P.	183.5	161	119	112	82.0
	(L.P.	185.0	164	118	106	76.9

N.C.C.

Age	Treatment	Length*	Width at hips	Width at pins	Width at femur-acetabulum	Internal width
29 weeks	Pre-treatment+	169.8	136.5	96.5	94.0	67.5
50 weeks	(H.P.	184.5	147	116	108	78.1
	(M.P.	180.5	143	108	100	69.3
	(L.P.	177.0	134	116	100	71.3
81 weeks	(H.P.	202.0	185	130	116	87.4
	(M.P.	195.0	178	120	115	88.4
	(L.P.	192.0	164	118	111	83.1

Born 1957

S.C.C.

Age	Treatment	Length*	Width at hips	Width at pins	Width at femur-acetabulum	Internal width
24 weeks	Pre-treatment+	165.3	130.0	100.5	92.0	67.0
50 weeks	(H.P.	176.5	144	112	100	72.8
	(M.P.	174.0	141	100	95	68.4
	(Hill	169.0	137	104	101	73.3
80 weeks	(H.P.	196.0	171	120	114	87.4
	(M.P.	195.0	170	117	111	81.8
	(Hill	188.0	161	119	110	82.8

N.C.C.

Age	Treatment	Length*	Width at hips	Width at pins	Width at femur-acetabulum	Internal width
24 weeks	Pre-treatment+	168.3	134.5	99.5	96.0	68.4
50 weeks	(H.P.	190.0	146	116	103	74.6
	(M.P.	172.0	132	103	97	66.4
	(Hill	166.0	126	102	93	64.8
80 weeks	(H.P.	195.0	164	127	119	85.7
	(M.P.	197.5	158	123	111	81.4
	(Hill	185.5	152	118	102	73.0

* Mean of both sides.
\+ Mean of two animals.

Table 57

Measurements of pelvic bones dissected from animals born 1956; H.P. and M.P. expressed as a percentage of L.P. and 50 and 81 weeks as a percentage of 29 weeks.

Born 1956

S.C.C.

			Length*	Width at hips	Width at pins	Width at femur-acetabulum	Internal width
50 weeks	% of L.P.	H.P.	107	107	114	104	101
		M.P.	102	103	105	102	101
	% of 29 week measurement	H.P.	111	111	123	114	111
		M.P.	106	107	113	112	111
		L.P.	104	104	108	110	110
81 weeks	% of L.P.	H.P.	107	104	103	105	111
		M.P.	99	98	100	106	107
	% of 29 week measurement	H.P.	122	128	131	122	128
		M.P.	113	122	127	122	123
		L.P.	114	124	127	116	116

N.C.C.

			Length*	Width at hips	Width at pins	Width at femur-acetabulum	Internal width
50 weeks	% of L.P.	H.P.	104	109	100	108	110
		M.P.	102	107	93	100	97
	% of 29 week measurement	H.P.	109	107	121	115	116
		M.P.	107	105	112	107	103
		L.P.	104	98	121	107	106
81 weeks	% of L.P.	H.P.	105	113	111	104	105
		M.P.	102	109	102	104	106
	% of 29 week measurement	H.P.	119	135	135	123	130
		M.P.	115	130	124	123	131
		L.P.	113	120	122	118	123

* Mean of both sides.

Table 57a

Measurements of pelvic bones dissected from animals born 1957; H.P. and M.P. expressed as a percentage of Hill and 50 and 80 weeks as a percentage of 24 weeks.

Born 1957

S.C.C.

			Length*	Width at hips	Width at pins	Width at femur-acetabulum	Internal width
50 weeks	% of Hill	H.P.	104	105	108	99	99
		M.P.	103	103	96	94	93
	% of 24 week measurement	H.P.	107	111	111	109	109
		M.P.	105	108	99	103	102
		Hill	102	105	103	110	109
80 weeks	% of Hill	H.P.	104	106	101	104	106
		M.P.	104	106	98	101	99
	% of 24 week measurement	H.P.	119	131	119	124	130
		M.P.	118	130	116	121	122
		Hill	114	124	118	120	124

N.C.C.

			Length*	Width at hips	Width at pins	Width at femur-acetabulum	Internal width
50 weeks	% of Hill	H.P.	114	116	114	111	115
		M.P.	104	105	101	104	102
	% of 24 week measurement	H.P.	113	109	117	107	109
		M.P.	102	98	104	101	97
		Hill	99	94	103	97	95
80 weeks	% of Hill	H.P.	105	108	108	117	117
		M.P.	106	104	104	109	112
	% of 24 week measurement	H.P.	116	122	128	124	125
		M.P.	117	117	124	115	119
		Hill	110	113	119	106	107

* Mean of both sides.

in the L.P./Hill animals and in all three treatment animals at the same two ages as a percentage of the same measurement prior to treatment.

At 12 months, post-treatment, between the H.P. and L.P./Hill animals, although there was a good deal of individual variation, on average there was a difference of 9% in both hip and pin width, 7% in length and 6% in both femur-acetabulum width and the internal width of the pelvic canal. Between the M.P. and L.P./Hill animals only in length and hip width was there any difference, the former averaging 3% and the latter 5%, while the other measurements were practically the same in both treatments. Over the treatment period in the H.P. animals, pin width showed the greatest increase, averaging 18%, while the other four measurements all increased on average by 10 - 11%. In the M.P. animals pin width again showed the greatest increase, averaging 7%, while femur-acetabulum width increased by 6%, length and hip width by 5% and internal width by only 3%. In the L.P./Hill animals the picture was very similar apart from length and hip width which increased hardly at all, while the other three measurements increased by as much as in the M.P. animals. Width or thickness growth of the bone structure of the pelvis obviously continues even on L.P./Hill wintering and must therefore have a considerable potential for growth at this time which is less affected by treatment than length growth and to some extent hip width.

At 18 months, between the H.P. and L.P./Hill animals the greatest difference was shown in internal width, averaging 10%, followed by hip width and femur-acetabulum width, both averaging 8%, with pin width 6%, and length 5%, showing the smallest differences. Between the M.P. and L.P./Hill animals the picture was very similar, internal width showing an average difference of 6%, femur-acetabulum width 5%, hip width 4%, length 3% and pin width only 1%. From prior to treatment to 18 months in the H.P. animals, hip, pin and internal width all increased by an average of 28%, while femur-acetabulum width increased by 23% and length by only 19%. In the M.P. animals the relative increases were similar, hip, pin and internal width all averaging 24%, femur-acetabulum width 20% and length 16%. In the L.P./Hill animals, hip and pin width increased by an average of 21% but internal width increased by only 18%, with the other two measurements increasing by 15% and 13% respectively. Regardless of treatment, length growth was very much less than width growth during this time, while hip width in particular increased considerably between 12 and 18 months. Treatment, however, does appear to have had a persistent effect on the internal width of the pelvic cavity, which suggests that lambing difficulties in the first productive year may be reduced by H.P. and possibly M.P. wintering.

8. Practical implications arising from dissection data. In the preceding sections the changes with age as affected by treatment have been studied on the body parts, organs and their accompanying tissues, total joints and tissues of the hindquarter joints in selected individuals from both breeds and both years. It is now intended to consider these specific trends with regard to their general implications in ewe hogg rearing and the subsequent ability of the animals to survive and produce lambs under a hill environment. While the effects of treatment at the end of the treatment period at 12 months are of interest, it is the persistence of these effects that obviously are of most importance. For this reason the 18 month situation will receive more attention in the following discussion.

All the essential organs of the body, the brain, eyes, kidneys and the contents of the thoracic cavity were affected by treatment to a limited extent only in so far as they were generally closely related to the weight of the animal, with the earlier developing organs like the brain and eyes being more related to age than treatment. Variations in wintering treatment are therefore unlikely to create in the organs differences which are critical to the animal's subsequent performance. However, no information is available on glandular development which may be affected and may have considerable influence on growth to maturity, metabolic activity and reproductive capacity.

The development of heavier digestive systems in animals wintered on artificial restricted diets of high fibre content than in animals well fed on balanced diets of concentrates plus roughage or animals wintered naturally on hill herbage has been discussed previously and may have some implications in practice. The hill wintered animals have obviously developed digestive systems to suit the available diet, with the appropriate bacterial flora for its efficient breakdown. The well fed animals have also developed digestive systems to suit their diet and with it consisting very largely of easily digested components they have not needed to develop such large systems as the poorly fed animals receiving only roughage of low digestibility. It is possible that on changing to a hill herbage diet the well fed animals would suffer to a greater extent that the poorly fed animals while the rumen bacterial flora altered to cope with the more fibrous intake, although both would receive a check compared with the hill wintered animals. However, by 18 months this appears to have been overcome and there was very little residual difference resulting from treatment in the development of the digestive system.

The reproductive organs, being late developing, have been shown to have a very great potential for growth both during the treatment period and over the following summer. Treatment had a very considerable influence on the development of these organs, H.P. wintering creating on average a difference of nearly 50% over L.P./Hill wintering at 12 months but M.P. wintering being little better than the latter. At 18 months, treatment differences persisted although reduced in magnitude, with an average of 18% between the H.P. and L.P./Hill weights and 8% between the M.P. and L.P./Hill. The 1957 born Hill animals appeared to overcome the difference during the summer to a greater extent than the 1956 born L.P. animals and while this may be due to checks in development resulting from change in diet and habitat in the latter it is more likely to be due to individual variation and chance selection. The greater development of the reproductive organs at 18 months in the better wintered animals seems very likely to reduce barrenness and increase prolificacy in the first productive year.

Of the internal fat depots, heart fat was least affected by treatment, while omentum and kidney fat were very greatly affected, the former to an even greater extent than the latter. Heart fat may, within limits, be a function of the weight of the heart itself and is probably the last of the internal fat depots to be reduced on a L.P./Hill diet and the last to be increased on a H.P. diet. Kidney fat is probably intermediate in this respect, while omentum fat is the first to be mobilised during starvation and the first to be laid down on a H.P. diet. Treatment had created such large differences in the latter two depots at 12 months that there were still sizable differences present at 18 months which may benefit the better reared animals during their second winter, having greater reserves to draw on during the stress of sub-optimum intake and pregnancy.

The early developing joints, like the head and feet, were much less affected by treatment than later developing joints whose potential for growth was at a maximum during the treatment period. The forequarters, being later developing than the hindquarters, were more affected by treatment than the latter but with the latter containing joints of different growth intensities during this time treatment effects were considerable on those with the highest intensities. Of the joints of the hindquarters the legs were least affected by treatment, being earlier maturing even than the total forequarters. The pelvis and loin were both later maturing than the legs and the latter more so than the former but both were affected by treatment to a considerable extent.

Although treatment was applied relatively late in the development of the legs, differences were created in the region of 55% between the H.P. and L.P./Hill weights and 22% between the M.P. and L.P./Hill weights at 12 months.

Being late in their development there was only a limited potential left for recovery after treatment and the differences were maintained at 22% and 9% respectively at 18 months. With the pelvis being slightly earlier in maturity than the loin and affected by treatment to a lesser but still considerable extent at 12 months, it also had probably passed its peak of maximum growth intensity and was unable to overcome the differences created by treatment during the following summer, unlike the loin which, being later maturing, was affected considerably by treatment during a relatively early stage in its growth and was therefore able to recover over the summer and greatly reduce the differences by 18 months. Between the H.P. and L.P./Hill animals and the M.P. and L.P./Hill animals at 12 months there were average differences of 82% and 28% respectively in the loin and 71% and 21% in the pelvis but at 18 months they had decreased to 16% and 8% respectively in the former and 25% and 15% in the latter.

From these results it appears probable that L.P./Hill wintering creates animals lighter in the shoulder, trunk and pelvis than animals wintered on H.P. or M.P. diets which create a chunkier, more thickset type of body but with legs little different from those of the L.P./Hill animals. This is an extension of the trends discussed in the section on live measurements where the effects of treatment on size and shape were examined.

Joints, however, are composed of three main tissues, bone, muscle and fat, with the latter in two forms, subcutaneous and intermuscular. To get a true picture of the effects of treatment on the joints it is necessary to examine the effects on each of the composit tissues. In the total hindquarters, bone, the earliest developing tissue, was least affected by treatment, with muscle, being later in development, slightly more affected. Fat, the latest developing tissue, was very greatly affected by treatment and subcutaneous fat, being later in development than intermuscular fat, was more affected than the latter. Bone, having a high potential for growth during the treatment period, continued to increase in weight on a L.P./Hill diet, while fat and to a limited extent, muscle, decreased. On a M.P. diet both bone and muscle increased at the expense of fat, which decreased, particularly subcutaneous fat. Bone obviously has the first call on available nutrients during this time, closely followed by muscle, with intermuscular fat next and subcutaneous fat having the last call. During sub-optimum feeding these tissues would be mobilised in reverse order, with bone unlikely to be reduced in the growing animal. However, in an adult sheep where bone growth has ceased and a lamb is being produced under conditions of semi-starvation and/or mineral deficiency, bone breakdown may occur. For this reason the greater bone development resulting from H.P. wintering and to a limited extent M.P. wintering, should provide the animal with a greater reserve of minerals in adult life than one which has been retarded by L.P./Hill wintering. Although the differences created by treatment at 12 months were very much smaller in bone than in the other tissues they were nevertheless very much more persistent to 18 months. Between the H.P. and L.P./Hill animals and the M.P. and L.P./Hill animals at 12 months there were average differences of 25% and 12% respectively in bone, 53% and 19% in muscle, 102% and 44% in intermuscular fat and 482% and 105% in subcutaneous fat. At 18 months bone still showed average differences of 17% and 9% respectively, while in muscle the differences had decreased to 21% and 10%, in intermuscular fat to 23% and 20% and in subcutaneous fat to 34% and 13%. It seems probable that the bone differences will persist in later life but the fat differences, while providing additional reserves in the better reared animals which will help to carry them over their second winter and first pregnancy, will disappear with age.

However, within the total hindquarters are joints which have been shown to have different growth intensities during the treatment period and to be differently affected by treatment. Each of these joints is made up of the three main tissues of greatly differing growth rates at that time and the response of the joints to treatment has therefore been examined with regard to the changes occurring in each of these tissues. Within each joint the tissues showed the same range of growth intensities as described in the total hindquarters but between the joints the degree of response to treatment varied considerably for each tissue.

In general the leg, being earlier developing, showed less response to treatment in all the tissues than the loin. Bone growth continued on a L.P./ Hill diet in the former but ceased in the latter, while muscle was slightly less affected in the former. Even on a M.P. diet the leg showed more bone growth, while muscle was similar but on a H.P. diet the loin had very much more potential for bone growth and increased considerably more than was the case in the leg. This can be explained by the H.P. diet shortening the physiological age of the animal and causing the late maturing lumbar vertebrae to grow at their maximum while on the other two diets they had not reached this stage by the end of the treatment period. Muscle, being intermediate in development, showed very little difference between these joints. Fat, however, showed very much the greatest difference between these joints in response to treatment, losing considerably more on a M.P. or L.P./Hill diet and gaining considerably more on a H.P. diet in the loin than in the leg, particularly subcutaneous fat.

The pelvis was intermediate in the response to treatment of most of the tissues but tended to show greater growth in both muscle and bone regardless of treatment than the loin and leg. This may be a characteristic of the female, the development of bone and muscle in this joint having a high potential in preparation for pregnancy and parturition.

At 18 months the differences created by treatment were more persistent in the leg than in the loin in all tissues except intermuscular fat. In the loin there was still a considerable potential for growth after the treatment period which was not present to the same degree in the earlier developing leg, particularly in subcutaneous fat and muscle. In the pelvis, although bone and muscle continued to increase very considerably in all treatments, the differences between them remained larger at 18 months than in the other two joints.

H.P. and to a limited extent M.P. wintering may therefore reduce the likelihood of lambing difficulties in the first productive year but it is not possible to predict the persistence of the differences between treatment in this joint subsequent to 18 months.

Both the loin and the pelvis are joints of greater potential for subcutaneous fat deposition than the leg, suffering more from sub-optimum feeding and responding more to adequate feeding. For this reason it is possible that too high a standard of rearing, with the development of excessive quantities of fat both within and on the pelvis, may completely cancel out any advantage arising from greater muscle and bone development with regard to lambing difficulties.

Bone growth in thickness has been more affected by treatment than length growth, particularly in the earlier developing bones of the leg. Later developing bones like the pelvis have been affected in both dimensions but more so in thickness and showed greater differences between treatments at 18 months. However, it is not certain that such differences will be as persistent subsequently as those created in the earlier developing bones on account of the former's still present potential for growth after the treatment period.

It is therefore suggested that the H.P. treatments and to a limited extent the M.P. treatments, have produced sheep with larger frames of thicker bone, with correspondingly greater muscle and more potential for fat deposition, particularly subcutaneous fat, than the L.P./Hill treatments. It is also suggested that this may result in improved production in the first productive year through the presence of greater reserves of fat and the greater development of both the pelvis, assisting ease of parturition, and the reproductive organs. However, it must also be stressed that this greater development of the skeleton with its correspondingly greater tissue development and resultant greater maintenance requirements may, if it persists as appears likely, become a disadvantage in later life under conditions of severe winter starvation and a fixed stocking rate.

V. Dental development

Eruption of the permanent incisor teeth.

At periodic intervals from just over a year old, all experimental animals were examined for the eruption of their permanent incisor teeth. Scoring, as described in Materials and Methods, section V, sub-section 4, was carried out to describe the degree of eruption. Actual mean scores and these as a percentage of L.P. or Hill are shown in Tables 58, 58a and 58b. Also in these tables are shown the number of animals starting to erupt as a fraction of the total number in each group. This describes the eruption of each pair of incisors in turn while the score system is an accumulative and continuous one. The fraction system includes all animals that are erupting, regardless of whether the incisors are just emerging or are fully up, while the scoring system makes an allowance for the degree of eruption and is therefore more specific. From these two systems it is possible to examine the effects of treatment on the time of initial start of eruption and on the time of full eruption of each pair of incisors.

According to Franklin (1950) there is a very wide range in the ages at which the permanent incisors erupt in sheep. From the work of several authorities he quotes the following ages for eruption:

first pair - 12 - 19 months,
second pair - 18 - 26 months,
third pair - 23 - 36 months,
fourth pair - 28 - 48 months.

Franklin suggests that the variation may be inherent or may be due to the wide range of nutritional conditions under which sheep are reared. This is borne out by Wiener and Purser (1957) who recorded both considerable breed and treatment differences, the latter resulting in earlier eruption with better feeding.

In the light of this, the present data has been examined for both breed and treatment effects, not only on the eruption of the first pair of incisors

Table 58

Eruption of permanent incisor teeth

Born 1956

S.C.C.

Age in weeks	Treatment	*No. of animals starting to erupt P.Is. as a fraction of the total group	Mean[+] score	Mean score as a % of L.P.
59	H.P.	3/10	1.80	-
	M.P.	0/11	0.00	-
	L.P.	0/12	0.00	-
72	H.P.	9/10	4.80	140
	M.P.	11/11	5.27	154
	L.P.	10/12	3.42	100
80	H.P.	10/10	5.80	104
	M.P.	11/11	5.64	101
	L.P.	12/12	5.58	100
101	H.P.	3/9	7.11	113
	M.P.	2/10	6.30	100
	L.P.	1/11	6.27	100
116	H.P.	7/8	10.75	126
	M.P.	7/9	10.11	118
	L.P.	5/11	8.55	100

*From 59 - 80 weeks = Number of animals starting to erupt the first pair of P.Is.
" 101 -116 " = " " " " " " " second " " "

Within each treatment group, the age at which each pair of P.Is. start to erupt is shown by a line.

[+]Based on a score of 3 points/P.I. fully erupted, 2 points/P.I. half erupted and 1 point/milk tooth missing.

Table 58 (contd.)

Eruption of permanent incisor teeth

Born 1956

S.C.C.

Age in weeks	Treatment	*No. of animals starting to erupt P.Is. as a fraction of the total group	Mean[+] score	Mean score as a % of L.P.
134	H.P.	4/8	14.38	116
	M.P.	7/9	15.22	122
	L.P.	2/11	12.45	100
152	H.P.	7/8	16.75	108
	M.P.	7/9	16.44	106
	L.P.	7/11	15.45	100
170	H.P.	0/8	18.00	102
	M.P.	2/9	18.44	104
	L.P.	1/11	17.73	100
185	H.P.	4/8	19.88	107
	M.P.	4/9	19.33	104
	L.P.	3/11	18.64	100
204	H.P.	5/8	21.00	108
	M.P.	4/9	19.67	102
	L.P.	3/11	19.36	100

*From 134 - 152 weeks = Number of animals starting to erupt the third pair of P.Is.
" 170 weeks onwards = " " " " " " " fourth " " "

Within each treatment group, the age at which each pair of P.Is. start to erupt is shown by a line.

[+]Based on a score of 3 points/P.I. fully erupted, 2 points/P.I. half erupted and 1 point/milk tooth missing.

Table 58 (contd.)

Eruption of permanent incisor teeth

Born 1956

N.C.C.

Age in weeks	Treatment	*No. of animals starting to erupt P.Is. as a fraction of the total group	Mean+ score	Mean score as a % of L.P.
59	H.P.	1/12	0.50	91
	M.P.	2/13	0.92	167
	L.P.	1/11	0.55	100
72	H.P.	12/12	5.33	125
	M.P.	13/13	5.38	126
	L.P.	9/11	4.27	100
80	H.P.	12/12	5.67	102
	M.P.	12/12	5.83	105
	L.P.	11/11	5.55	100
101	H.P.	0/11	6.00	87
	M.P.	5/11	7.64	111
	L.P.	3/10	6.90	100
116	H.P.	9/10	10.30	96
	M.P.	9/9	11.33	106
	L.P.	9/10	10.70	100

*From 59 - 80 weeks = Number of animals starting to erupt the first pair of P.Is.
" 101 - 116 " = " " " " " " " second " " "

Within each treatment group, the age at which each pair of P.Is. start to erupt is shown by a line.

+Based on a score of 3 points/P.I. fully erupted, 2 points/P.I. half erupted and 1 point/milk tooth missing.

Table 58 (contd.)

Eruption of permanent incisor teeth.

Born 1956

N.C.C.

Age in weeks	Treatment	*No. of animals starting to erupt P.Is. as a fraction of the total group	Mean[+] score	Mean score as a % of L.P.
134	H.P.	5/10	14.20	97
	M.P.	4/9	14.44	99
	L.P.	6/10	14.60	100
152	H.P.	9/10	17.20	96
	M.P.	8/9	17.11	95
	L.P.	10/10	18.00	100
170	H.P.	5/10	20.40	105
	M.P.	3/9	19.44	100
	L.P.	3/10	19.50	100
185	H.P.	7/10	21.30	104
	M.P.	5/9	20.67	101
	L.P.	5/10	20.40	100
204	H.P.	9/10	22.80	107
	M.P.	5/8	21.75	102
	L.P.	7/10	21.30	100

*From 134 - 152 weeks = Number of animals starting to erupt the third pair of P.Is.
" 170 weeks onwards = " " " " " " " fourth " " "

Within each treatment group, the age at which each pair of P.Is. start to erupt is shown by a line.

[+]Based on a score of 3 points/P.I. fully erupted, 2 points/P.I. half erupted and 1 point/milk tooth missing.

Table 58a

Eruption of permanent incisor teeth.

Born 1957

S.C.C.

Age in weeks	Treatment	*No. of animals starting to erupt P.Is. as a fraction of the total group	Mean[+] score	Mean score as a % of Hill
58	H.P.	6/12	2.33	583
	M.P.	1/9	0.22	55
	Hill	1/10	0.40	100
68	H.P.	10/11	5.45	321
	M.P.	8/9	4.56	268
	Hill	4/10	1.70	100
79	H.P.	11/11	6.00	107
	M.P.	9/9	6.00	107
	Hill	10/10	5.60	100
100	H.P.	6/10	8.70	145
	M.P.	3/8	7.38	123
	Hill	0/9	6.00	100
118	H.P.	6/10	13.80	128
	M.P.	1/8	12.25	114
	Hill	0/9	10.78	100
134	H.P.	8/10	16.40	108
	M.P.	5/8	15.25	100
	Hill	7/9	15.22	100
152	H.P.	2/10	17.80	107
	M.P.	0/8	18.00	108
	Hill	0/9	16.67	100

*From 58 - 79 weeks = Number of animals starting to erupt the first pair of P.Is.
At 100 weeks = " " " " " " " second " " "
From 118 - 134 weeks = " " " " " " " third " " "
At 152 weeks = " " " " " " " fourth " " "

Within each treatment group, the age at which each pair of P.Is. start to erupt is shown by a line.

[+]Based on a score of 3 points/P.I. fully erupted, 2 points/P.I. half erupted and 1 point/milk tooth missing.

Table 58a (contd.)

Eruption of permanent incisor teeth.

Born 1957

N.C.C.

Age in weeks	Treatment	*No. of animals starting to erupt P.Is. as a fraction of the total group	Mean[+] score	Mean score as a % of Hill
58	H.P.	4/13	1.46	-
	M.P.	1/13	0.38	-
	Hill	0/13	0.00	-
68	H.P.	11/13	4.54	227
	M.P.	10/13	4.38	219
	Hill	6/13	2.00	100
79	H.P.	13/13	6.00	108
	M.P.	13/13	6.00	108
	Hill	12/13	5.54	100
100	H.P.	5/12	7.17	120
	M.P.	6/12	8.57	143
	Hill	0/12	6.00	100
118	H.P.	0/11	11.82	107
	M.P.	4/12	13.33	120
	Hill	1/12	11.08	100
134	H.P.	5/11	14.09	108
	M.P.	9/12	16.33	126
	Hill	2/12	13.00	100
152	H.P.	1/11	17.09	107
	M.P.	3/12	18.33	115
	Hill	0/12	16.00	100

*From 58 - 79 weeks = Number of animals starting to erupt the first pair of P.Is.
At 100 weeks = " " " " " " " second " " "
From 118 - 134 weeks = " " " " " " " third " " "
At 152 weeks = " " " " " " " fourth " " "

Within each treatment group, the age at which each pair of P.Is. start to erupt is shown by a line.

+Based on a score of 3 points/P.I. fully erupted, 2 points/P.I. half erupted and 1 point/milk tooth missing.

Table 58b

Eruption of permanent incisor teeth

Born 1958

Age in weeks	Treatment	S.C.C. *No. of animals starting to erupt P.Is. as a fraction of the total group	S.C.C. Mean[+] score	S.C.C. Mean score as a % of Hill	N.C.C. *No. of animals starting to erupt P.Is. as a fraction of the total group	N.C.C. Mean[+] score	N.C.C. Mean score as a % of Hill
66	Away	8/13	2.62	243	10/15	2.60	163
	Hill	3/13	1.08	100	6/15	1.60	100
82	Away	13/13	6.00	101	15/15	6.00	100
	Hill	13/13	5.92	100	15/15	6.00	100
100	Away	1/13	6.46	108	1/15	6.40	107
	Hill	0/13	6.00	100	0/15	6.00	100

*From 66 - 82 weeks = Number of animals starting to erupt the first pair of P.Is.
At 100 weeks = " " " " " " " second " " "

Within each treatment group, the age at which each pair of P.Is. start to erupt is shown by a line.

+Based on a score of 3 points/P.I. fully erupted, 2 points/P.I. half erupted and 1 point/milk tooth missing.

as described by Wiener and Purser in the above report but also on the eruption of the subsequent pairs.

As it seemed possible that eruption might be closely related to age, the regression of eruption score at 72 weeks of age in the 1956 born S.C.C. hoggs was calculated on birth date (1st April = 1, 2nd April = 2 and so on till 1st May = 31, 2nd May = 32, etc.). A within group regression coefficient of -0.0916 was calculated (Snedecor, 1956), which, with a S.E. of 0.0721, was not significantly different from zero. Birth date variation has therefore been ignored in comparing eruption scores between groups.

In the 1956 born animals at 59 weeks, eruption of the first pair of incisors had started in the S.C.C. H.P. group only and in all three N.C.C. groups. However, in two of the N.C.C. groups only one case was observed with two cases in the third group, while in the S.C.C. H.P. group the three cases constituted 30% of the total. By 72 weeks, eruption was well under way in both breeds with the L.P. groups being slightly retarded as is shown by the scoring and percentage scoring. From the scoring both M.P. groups appear to be further advanced than the others on a group basis but when the percentage of fully erupted pairs in each group is considered the retarding effect of poorer treatment becomes apparent, i.e.,

S.C.C. H.P. 70% M.P. 54% L.P. 33%.

N.C.C. H.P. 90% M.P. 62% L.P. 54%.

By 80 weeks, eruption had started in all animals but as can be seen from the scoring, the first pair of incisors were not fully up in every case.

In the 1957 born animals at 58 weeks, eruption of the first pair of incisors had started in all groups with the exception of the N.C.C. Hill group. Only one case was observed in each of the S.C.C. M.P. and Hill groups and one in the N.C.C. M.P. group. In the H.P. groups, however, in spite of the earlier examination, eruption was well under way, particularly in the S.C.C. breed. This apparently earlier eruption on the part of the H.P. groups this year than was the case in 1956 can probably be explained by the earlier and longer treatment period and the higher standard of feeding. At 68 weeks, a month earlier for the second examination than in the 1956 born age group, the treatment differences were striking, particularly in the scoring and percentage scoring. This is borne out by the percentage of fully erupted pairs in each group at this time, namely:-

S.C.C.	H.P. 91%	M.P. 56%	Hill 10%.
N.C.C.	H.P. 69%	M.P. 69%	Hill 23%.

By 79 weeks, eruption had started in all animals except one in the N.C.C. Hill group. From the scoring it can be seen that the first pair of incisors were fully grown in all animals in both H.P. and M.P. groups. These animals were therefore much further advanced at this time than the corresponding groups born 1956. In neither Hill group at 79 weeks were the first pair of incisors fully up in every case and the scores were very similar to those of the 1956 born L.P. groups at 80 weeks.

In the 1958 born animals, where the treatments were less extreme than in the previous two years, the first examination was carried out at 66 weeks, two weeks earlier than the 1957 born second recording. Eruption of the first pair of incisors had started in both groups in both breeds. In spite of the limited differences in growth created by the treatments in this year, both Away groups had over 60% of animals erupting compared with under 40% for the two Hill groups. The S.C.C. Hill group also appeared to be slightly retarded relative to the N.C.C. Hill group, as is shown by the scoring. This was still apparent at 82 weeks, the S.C.C. Hill group being the only one in which the incisors were not fully up in every case, although eruption had started in all animals.

Before going on to discuss the eruption of the 2nd, 3rd and 4th pairs of incisors a brief summary of the eruption of the first pair as affected by breed and treatment is in order, in view of the greater stress put on them by all authorities and in view of the smaller variation in time of eruption exhibited by them under normal conditions.

In the following table the percentage of animals in which the first pair of incisors had started to erupt at 58 - 59 weeks of age is shown for each breed as a mean of the two years 1956 and 1957. Also shown is the year mean regardless of breed and the total mean of both breeds and both years.

	S.C.C. Mean	N.C.C. Mean	Total Mean	1956 Mean	1957 Mean
H.P.	40	20	30	19	41
M.P.	6	12	9	8	10
L.P./Hill	5	5	5	5	5
Total mean	17	12	15	11	19

It can be seen from the middle column in the table that treatment has had a considerable effect on the time of eruption, with H.P. feeding resulting in very much earlier commencement. Ignoring treatment, it does appear that the S.C.C. breed started their eruption earlier than the N.C.C. breed but the difference was very slight and when treatment is considered, it was in the H.P. groups that the greatest difference existed, with an apparently opposite effect showing in the M.P. groups.

Ignoring breed and considering the year effects, it is obvious that the earlier start to the treatment period in 1957 and the greater growth in the H.P. groups has resulted in a considerably earlier start to incisor eruption in those groups in that year. In the other groups where growth was pre-determined along similar lines each year there was virtually no difference.

Of the heavy and light hoggs at the start of the treatment period, the percentage in each group which had started to erupt at 58 - 59 weeks is shown as follows as a mean of both years and breeds:-

Heavy, H.P. 37 M.P. 14 L.P./Hill 5.

Light, H.P. 22 M.P. 5 L.P./Hill 5.

Although the numbers involved in these sub-groups were small, it does appear that the treatment effects were more pronounced in the heavy hoggs, with only the H.P. sub-group showing any degree of earlier eruption in the light hoggs.

In the 1956 born animals at 101 weeks, eruption of the second pair of incisors had started in all treatment groups except the N.C.C. H.P., which was repeating its delayed eruption of the first pair. In the other two N.C.C. groups, eruption was well under way, while in the S.C.C. breed the H.P. group was once again much earlier than the M.P. and L.P. At 116 weeks, only the S.C.C. L.P. group were showing any signs of retardation, with all the other groups in both breeds being about the same stage as is shown by the mean scores.

By 134 weeks, the third pair of incisors had started to erupt in all treatment groups. No distinct treatment differences existed in the N.C.C. breed. In the S.C.C. breed the L.P. group once again were retarded relative to the H.P. and M.P. groups, a situation that was still present, though diminished, at 152 weeks.

The fourth and final pair of incisors had started to erupt by 170 weeks in all treatment groups except the S.C.C. H.P. With only two animals erupting in the S.C.C. M.P. and one in the S.C.C. L.P. it is obvious that there was little difference between treatments at this time and examination of the scoring bears this out. However, at 185 weeks, treatment differences had reappeared and due to the great variation in time of eruption of the last pair of incisors, had increased at 204 weeks. In the N.C.C. groups, eruption of the final pair was much further advanced at 170 weeks than that of the S.C.C. groups. Treatment differences also had reappeared and were maintained through 185 weeks to 204 weeks.

In the 1957 born animals at 100 weeks, eruption of the second pair of incisors was well under way in the H.P. and M.P. groups in both breeds. In both Hill groups the first pair of incisors were fully up but there was no sign of the second pair. At 118 weeks, the third pair of incisors had started to erupt in all groups except the S.C.C. Hill and the N.C.C. H.P. Eruption was well under way in the S.C.C. H.P. group and the N.C.C. M.P. group but only one case was observed in each of the other two groups, i.e. S.C.C. M.P. and N.C.C. Hill. At 134 weeks, eruption of the third pair of incisors was well under way in all three S.C.C. groups, with only a little earlier development in the H.P. In the N.C.C. breed, the M.P. group were well in advance of the others but the H.P. group had also advanced and it was only in the Hill group that retardation was still apparent. At 152 weeks, eruption of the fourth and final pair of incisors had started in both H.P. groups and also in the N.C.C. M.P. group.

In the 1958 born animals at 100 weeks, eruption of the second pair of incisors was observed in one case only in each of the Away groups.

It is obvious from Tables 58, 58a and 58b and from the above discussion that to get an accurate picture of the eruption of the permanent incisor teeth it is ideally necessary to record them at frequent and regular intervals. This is difficult to do with hill sheep and examination had therefore to be carried out at the routine gatherings. From this it can be seen that the optimum time for demonstration of differences due to treatment in time of eruption may in fact have been missed. In other words, if records had been taken at certain times prior to or between those used in this study, the effects of treatment may have been even more strikingly demonstrated. Nevertheless, it can be said in summary that the better the level of feeding in the first winter the earlier the first pair of incisors start to erupt. This in the case of H.P. wintering is at about 12 months of age and it may be anything up to two months earlier than from L.P. or Hill wintering.

Treatment effects appear to be still present in the time of eruption of the 2nd, 3rd and 4th pairs of incisors, although of diminished magnitude, with the L.P. and Hill groups being the latest and the M.P. groups the earliest. This is shown by the percentage of animals in both breeds and both years erupting the 2nd pair at 100 - 101 weeks and the 3rd pair at 134 weeks, namely:-

	100 - 101 weeks. 2nd pair.	134 weeks. 3rd pair.
H.P.	34	56
M.P.	39	65
L.P./Hill	10	43

This situation is difficult to explain but may be due to a check in development experienced by the H.P. groups at the end of wintering, on being returned to the hill, which was too late to affect the eruption of the first pair and which was not experienced by the M.P. groups.

Though the tremendous variation in time of eruption which existed makes interpretation of results from the small numbers very difficult, there are two points of interest which must be mentioned.

These are the overall shortening of the time required to reach dental maturity at the full mouth stage when fed on a H.P. diet of the quantity and for the length of time as was the case in the 1957 born age group compared with the 1956 born age group and the difference in time of eruption of the first pair of incisors between the 1956 born L.P. and the 1957 born Hill groups. The first point suggests an overall condition of earlier maturity with forcing or H.P. rearing in early life and is worthy of further study. The second point suggests an insufficient knowledge of the mechanism regulating tooth eruption which although quite obviously affected by the degree of level of feeding in early life may be much more dependent upon the quality of feeding. This in itself would constitute a complete research problem and would be of considerable value.

VI. Mortality

The numbers of ewes dying from natural causes in the treatment groups in the three experimental ages are shown over the different stages in life in Table 59. During the treatment period, only one animal died, this in the S.C.C. 1957 born Hill group. Over the summer after treatment, four S.C.C. animals died, one each in the three H.P. and Away groups and one in the 1957 born M.P. group. Only one N.C.C. sheep died during this time, in the 1956 born M.P.

Table 59

Number of ewes dying from natural causes*

	Born 1956			Born 1957			Born 1958		
	H.P.	M.P.	L.P.	H.P.	M.P.	Hill	Away	Hill	Totals
S.C.C.									
6 - 12 months (Treatment period)	0	0	0	0	0	1	0	0	1
12 - 18 months	1	0	0	1	1	0	1	0	4
18 - 30 months	0	0	0	0	0	0	0	1	1
30 - 42 months	0	0	0	0	0	0	-	-	0
42 - 54 months	0	0	0	-	-	-	-	-	0
Totals	1	0	0	1	1	1	1	1	6
N.C.C.									
6 - 12 months (Treatment period)	0	0	0	0	0	0	0	0	0
12 - 18 months	0	1	0	0	0	0	0	0	1
18 - 30 months	1	2	0	1	0	0	1	0	5
30 - 42 months	0	0	0	0	0	0	-	-	0
42 - 54 months	0	0	0	-	-	-	-	-	0
Totals	1	3	0	1	0	0	1	0	6
Ignoring breed, Totals	2	3	0	2	1	1	2	1	12

	H.P. and Away	M.P.	L.P. and Hill
Grouping 3 years' treatments, both breeds.	6	4	2
Number of ewes at start of experiment.*	72	42	71
Total % mortality	8.3	9.5	2.8

* Ewes removed from experiment on account of losing their ears from yellowses and ewes lost in a snowdrift are here excluded from both the total numbers and from the numbers dying.

group. Over the first productive year, one S.C.C. animal died, in the 1958 born Hill group, while five N.C.C. animals died, one each in the three H.P. and Away groups and the other two in the 1956 born M.P. group. In neither breed were there any deaths between 30 and 54 months in the 1956 born age group, nor between 30 and 42 months in the 1957 born age group.

Taking the S.C.C. totals gives two deaths from Hill wintered groups and none from L.P., two deaths from H.P. and one from Away, and only one from M.P. In the N.C.C. totals, there were no deaths from Hill or L.P. wintered groups, two deaths from H.P. and one from Away, and three from M.P. The numbers of sheep involved in any one treatment group being small and the resultant numbers of deaths being even smaller makes interpretation of these results very difficult. However, by grouping the three years' treatments in each breed individually and also together it is possible to get an indication of the effects of treatment, although no doubt complicated by other factors, on the mortality rate. The overall totals shown in Table 59 indicate the H.P./Away and M.P. groups each losing roughly three times the percentage of ewes lost by the L.P./Hill groups. When the breed percentages are separately calculated the following is the picture:-

	H.P./Away	M.P.	L.P./Hill
S.C.C.	8.8%	5.3%	5.9%
N.C.C.	8.0%	13.0%	0%

The greatest loss from the S.C.C. breed was in the H.P./Away groups with the smallest loss from the M.P. although this was little different from that of the L.P./Hill groups. The N.C.C. H.P./Away loss was nearly similar to that of the equivalent S.C.C. groups but much smaller than that of the N.C.C. M.P., with no losses at all from the L.P./Hill reared animals in this breed. These results suggest that the greater the upset and forcing in early life the greater is the likelihood of premature loss. The breed difference in the M.P. groups is of great interest when considered in terms of their performance after the treatment period. The S.C.C. M.P. groups lost a smaller percentage of ewes and became the poorest in the breed in terms of live weight and productivity while the N.C.C. M.P. groups lost a much greater percentage of ewes and became the best in the breed.

VII. Productivity

1. Wool production. Mean fleece weights and the significance of differences between treatment groups are shown for the four years 1957-1960 in Table 60. In this time, the 1956 born animals produced four clips, the 1957 three clips and the 1958 two.

With the 1956 born S.C.C. animals as hoggs in 1957, the treatment differences were all highly significant with the H.P. group producing about $1\frac{3}{4}$ lb. more wool per head than the L.P. group and the M.P. group being intermediate. In 1958, the H.P. group still produced about 1 lb. more wool per head than the L.P. group, with the M.P. group again intermediate but due to considerable variation and small numbers it was not possible to prove these differences significant. This situation was repeated in 1959 and 1960 but in 1960 the variability was sufficiently reduced for the L.P. yield to be significantly lighter than that of both the H.P. and M.P. groups. Over the four years, the H.P. animals produced a total of $4\frac{3}{4}$ lb. more wool/head than the L.P. animals, an average of almost $1^{1}/_{5}$ lb. more/year, while similarly the M.P. animals produced a total of $2^{2}/_{3}$ lb. more/head, an average of $\frac{3}{4}$ lb. more/year.

It must be mentioned at this point that only the hogg clip is valid for true comparison. Subsequent clips are biased by differential productivity and barrenness which although possibly due to some extent to treatment may nevertheless introduce a greater degree of variability in yield than is acceptable for statistical comparison.

With the 1956 born N.C.C. animals as hoggs in 1957, none of the treatment differences were significant, although the H.P. yield was almost $\frac{3}{4}$ lb. and

Table 60

Mean fleece weights and significance of differences between them.
(Weights in lb. and number of animals in brackets).

S.C.C.

Clip	Born 1956 H.P.	Born 1956 M.P.	Born 1956 L.P.	Born 1957 H.P.	Born 1957 M.P.	Born 1957 Hill	Born 1958 Away	Born 1958 Hill
1957 clip	4.88(10)			-			-	
	***	4.00(11)			-			
	***	**	3.17(12)			-		-
1958 clip	4.80(8)			4.58(12)			-	
	NS	4.16(9)		***	3.58(9)			
	NS	NS	3.73(9)+	**	NS	3.83(10)		-
1959 clip	5.16(8)			5.08(10)			4.54(13)	
	NS	4.71(9)		NS	5.45(8)			
	NS	NS	4.25(11)	NS	NS	4.50(9)	NS	4.54(13)
1960 clip	4.26(8)			4.04(10)			4.45(13)	
	NS	4.21(7)		NS	4.03(7)			
	*	*	3.25(11)	NS	NS	3.89(9)	NS	4.67(12)

N.C.C.

Clip	Born 1956 H.P.	Born 1956 M.P.	Born 1956 L.P.	Born 1957 H.P.	Born 1957 M.P.	Born 1957 Hill	Born 1958 Away	Born 1958 Hill
1957 clip	4.51(12)			-			-	
	NS	4.37(12)			-			
	NS	NS	3.85(10)			-		-
1958 clip	4.73(11)			5.35(12)			-	
	*	5.71(9)		***	3.88(13)			
	NS	***	4.39(10)	***	NS	3.80(13)		-
1959 clip	5.34(10)			5.30(12)			3.89(15)	
	NS	5.50(9)		NS	5.56(12)			
	NS	NS	4.76(10)	NS	NS	5.29(12)	NS	3.93(15)
1960 clip	4.36			3.98(11)			4.01(14)	
	NS	4.73(8)		NS	4.40(12)			
	NS	NS	4.69(10)	NS	NS	3.92(12)	NS	4.01(15)

+ 2 animals completely peeled before clipping.

*** = Significant at the 0.1% level of probability.
** = " " " 1% " " "
* = " " " 5% " " "
NS = Non-significant.

the M.P. yield $\frac{1}{2}$ lb. heavier than that of the L.P. group. The failure to achieve a significant difference in yield between the two extreme treatments was largely due to interference with the H.P. heart girth wool described earlier and the resultant high variability. In 1958, the M.P. yield was significantly heavier than that of both the H.P. and L.P. groups, being 1 lb. heavier than the former and over $1\frac{1}{4}$ lb. heavier than the latter. This suggests that wool yield is very closely related to body weight and size and that the effects of treatment may be twofold, namely by their action upon the animal's size as well as upon the metabolism of wool growth. The situation was very similar in 1959 but the differences had almost halved and were no longer significant. Very little difference existed between the treatment means in 1960 and certainly no significant difference. The lightest yield this year came from the H.P. group but again this may be a function of the differential productivity discussed above. Over the four years, the M.P. animals produced a total of nearly $2\frac{1}{2}$ lb. more wool/head than the L.P. animals, an average of almost $^{2}/_{3}$ lb. more/year and they also produced a total of $1\frac{1}{4}$ lb. more/head than the H.P. animals, this being almost $^{1}/_{3}$ lb. more/year.

With the 1957 born S.C.C. animals as hoggs in 1958, the H.P. yield was significantly heavier than that of both the M.P. and Hill groups, being 1 lb. heavier than the former and $\frac{3}{4}$ lb. heavier than the latter. In 1959, the M.P. yield was almost 1 lb. heavier than that of the Hill group and $^{1}/_{3}$ lb. heavier than that of the H.P. group but the variation throughout was too high to allow significance. In 1960, there were virtually no differences between the treatment means. Over the three years, the H.P. animals produced a total of $1\frac{1}{2}$ lb. more wool/head than the Hill animals, an average of $\frac{1}{2}$ lb. more/year, while similarly the M.P. animals produced a total of over $\frac{3}{4}$ lb. more/head, an average of $\frac{1}{4}$ lb. more/year.

With the 1957 born N.C.C. animals as hoggs in 1958, the H.P. yield was significantly heavier than that of both the M.P. and Hill groups, being approximately $1\frac{1}{2}$ lb. heavier than each of them. As with the S.C.C. breed there was no significant difference between the M.P. and Hill groups. In 1959, the M.P. yield was $\frac{1}{4}$ lb. heavier than that of the other two groups but this difference was not significant. This situation was repeated in 1960 and although the difference was doubled, being almost $\frac{1}{2}$ lb., it was not significant. Over the three years, the H.P. animals produced a total of $1\frac{3}{4}$ lb. more wool/head than the Hill animals, an average of over $\frac{1}{2}$ lb. more/year, while similarly the M.P. animals produced a total of over $\frac{3}{4}$ lb. more/head, an average of $\frac{1}{4}$ lb. more/year.

With both the S.C.C. and N.C.C. 1958 born animals as hoggs in 1959 and also in 1960 there were no differences between the treatment yields.

From the above results it is apparent that the treatments have had the greatest effect on wool yield at the first clipping as hoggs. The H.P. animals in 1956 and 1957 produced from 17 - 54% more wool than the respective L.P. or Hill animals at the first clip, an average of some 33% more. The M.P. animals produced from 7% less to 26% more wool than the respective L.P. or Hill animals, an average of 9% more.

In general it was only in the hogg clip that the differences between treatments could be proved significant. However, there were exceptions to this rule but it is probable that these were the result of factors outwith the treatments, although possibly interactions between them may have played a part. In the 1956 born animals, the S.C.C. H.P. and M.P. groups produced in four clips some 33% and 19% more wool respectively than the L.P. group, while the N.C.C. H.P. and M.P. groups produced some 7% and 14% more, so that over the four years, while the hogg clip produced the largest differences between treatments, there were nevertheless still some differences at the later clips, particularly in the S.C.C. breed. In the 1957 born animals, there was very little difference between treatment yields subsequent to the hogg clip and in both breeds the H.P. and M.P. groups produced in three clips some 13% and 6% more wool respectively than the

Hill groups.

There are two points of considerable interest arising from these results. One is the failure of the M.P. groups born 1957 to produce more wool as hoggs than the Hill groups, in spite of considerably better feeding and a resultant larger size. This may be explained by the check in growth and development experienced by the M.P. groups when being introduced to their wintering diet in the early autumn at a time when the growth potential of wool is still at a relatively high level (Doney and Smith, 1961). The Hill groups did not receive this check. The greater size of the M.P. animals was however demonstrated by their heavier yield of wool in the second clip compared with the Hill animals. The other point of interest is this relatively greater improvement in the M.P. second clip compared with the H.P. animals, particularly in the N.C.C. breed but also in the S.C.C. animals born 1957. While very largely related to size and condition as discussed in the sections on live weight and live measurements it may also be related to the check in development experienced by the H.P. animals during the summer relative to the M.P. animals, which retarded wool growth at its stage of maximum growth.

2. Lamb production.

(a) Non-productive ewes and lambs born and reared. The number of non-productive ewes and lambs born and reared in the treatment groups are shown in Table 61. In this report it is only possible to include part of the productive life of the experimental sheep and this covers three lamb crops for the 1956 born animals, two lamb crops for the 1957 born and one lamb crop for the 1958 born. Lambs which were born to the experimental sheep but were fostered off and reared outwith their parent treatment group are included in the latter's count at marking and weaning. In addition, any lambs fostered on to experimental sheep are excluded from the foster mother's treatment count. As the difference in lambing percentage between birth and weaning is caused by lamb losses over that

Table 61

Number of non-productive ewes, lambs born and lambs reared to marking and weaning as a percentage of the number of ewes mated. Actual numbers in brackets.

S.C.C.

		Born 1956			Born 1957			Born 1958	
		H.P.	M.P.	L.P.	H.P.	M.P.	Hill	Away	Hill
1958 lamb crop	No. of ewes	8	9	11	-	-	-	-	-
	% non-productive*	38(3)	33(3)	36(4)	-	-	-	-	-
	Lambing % Birth	63(5)	67(6)	64(7)	-	-	-	-	-
	Lambing % Marking	38(3)	33(3)	36(4)	-	-	-	-	-
	Lambing % Weaning	38(3)	22(2)	36(4)	-	-	-	-	-
1959 lamb crop	No. of ewes	8	9	11	10	8	9	-	-
	% non-productive*	38(3)	0	0	20(2)	25(2)	33(3)	-	-
	Lambing % Birth	63(5)	111(10)	109(12)	110(11)	88(7)	67(6)	-	-
	Lambing % Marking	63(5)	89(8)	91(10)	80(8)	50(4)	33(3)	-	-
	Lambing % Weaning	50(4)	78(7)	73(8)	70(7)	38(3)	33(3)	-	-
1960 lamb crop	No. of ewes	8	9	11	10	8	9	13	13
	% non-productive*	13(1)	11(1)	9(1)	10(1)	13(1)	22(2)	15(2)	23(3)
	Lambing % Birth	100(8)	111(10)	100(11)	100(10)	100(8)	89(9)	85(11)	77(10)
	Lambing % Marking	88(7)	78(7)	64(7)	100(10)	75(6)	56(5)	69(9)	62(8)
	Lambing % Weaning	88(7)	78(7)	55(6)	90(9)	75(6)	44(4)	62(8)	62(8)

* Includes both barren ewes and early abortions.

Table 61 (contd.)

Number of non-productive ewes, lambs born and lambs reared to marking and weaning as a percentage of the number of ewes mated. Actual numbers in brackets.

		N.C.C.							
		Born 1956			Born 1957			Born 1958	
		H.P.	M.P.	L.P.	H.P.	M.P.	Hill	Away	Hill
1958 lamb crop	No. of ewes	11	11	10	-	-	-	-	-
	% non-productive*	18(2)	27(3)	30(3)	-	-	-	-	-
	Lambing % Birth	100(11)	73(8)	80(8)	-	-	-	-	-
	Lambing % Marking	64(7)	64(7)	60(6)	-	-	-	-	-
	Lambing % Weaning	55(6)	55(6)	40(4)	-	-	-	-	-
1959 lamb crop	No. of ewes	10	9	10	12	12	12	-	-
	% non-productive*	0	11(1)	20(2)	17(2)	8(1)	25(3)	-	-
	Lambing % Birth	120(12)	111(10)	80(8)	100(12)	142(17)	75(9)	-	-
	Lambing % Marking	110(11)	100(9)	80(8)	92(11)	117(14)	75(9)	-	-
	Lambing % Weaning	100(10)	100(9)	80(8)	83(10)	117(14)	75(9)	-	-
1960 lamb crop	No. of ewes	10	8	10	11	12	12	15	15
	% non-productive*	0	0	0	9(1)	8(1)	17(2)	0	0
	Lambing % Birth	140(14)	138(11)	120(12)	109(12)	117(14)	100(12)	107(16)	100(15)
	Lambing % Marking	120(12)	138(11)	90(9)	73(8)	83(10)	83(10)	87(13)	93(14)
	Lambing % Weaning	110(11)	113(9)	80(8)	73(8)	83(10)	75(9)	80(12)	93(14)

* Includes both barren ewes and early abortions.

period, Table 62 should also be studied during the following discussion on lambing percentages.

Born 1956. The 1956 born animals in their first productive year as gimmers in 1958 had rather a high percentage of non-producers. These were, however, not entirely barren ewes but included a high percentage of early abortions, probably brought about by a fairly severe late winter and early spring. There was little apparent treatment effect in either breed with only the N.C.C. H.P. group having slightly fewer non-producers. In general it may also be said that the N.C.C. breed as a whole contained slightly fewer non-productive ewes than the S.C.C. breed regardless of treatment.

With this relatively high percentage of non-productive ewes, the percentage of lambs born per ewe mated was as a result rather low this year. No treatment differences existed at birth in the S.C.C. breed. In the N.C.C. breed, two pairs of twins and one fewer non-productive ewe resulted in the H.P. group producing 20 - 27% more lambs than the other two groups. The L.P. group's 7% advantage over the M.P. was entirely due to the presence of one pair of twins in the former.

The severity of the environment this year resulted in considerable losses of lambs, mainly due to the gimmers' failure to develop mammary tissue and produce milk. This was particularly so in the S.C.C. M.P. group. These heavy losses after the limited initial production resulted in very low weaning percentages, particularly in the S.C.C. breed, where the only treatment effect was that of approximately 15% fewer lambs in the M.P. group. In the N.C.C. breed, the only treatment effect was 15% fewer lambs weaned in the L.P. group.

In the second lamb crop produced by the 1956 born animals in 1959, the S.C.C. M.P. and L.P. groups, with no non-productive ewes and one pair of twins apiece produced the same percentage of lambs at birth and after similar losses weaned approximately the same percentage. The S.C.C. H.P. group, however, had a large percentage of non-producers and no twins, resulting in a lower percentage of lambs at birth than the other two groups and, even although subsequent losses were small, a lower percentage at weaning. This failure on the part of the H.P. group is difficult to explain, particularly as it was not repeated in the N.C.C. breed, where the H.P. group was the only one without non-producers. While it may be due entirely to chance, a possible explanation, however, is that H.P. rearing followed by failure to rear a lamb in the first year has resulted in an undesirable state of overfatness by the second tupping season. This may have been the cause of failure to breed in two of the cases, the third animal failed to breed in the first year and also in the third year and was probably a congenital non-breeder. In the N.C.C. H.P. group the same degree of first year non-rearing did not occur. Both the N.C.C. H.P. and M.P. groups produced two pairs of twins each so the difference at birth was entirely due to the M.P. group's one non-producer. By weaning, this difference had disappeared. The L.P. group, however, with two non-producers, and no twins, produced very much fewer lambs at birth than the other two groups. In spite of no losses, the weaning percentage was still much lower than that of the H.P. and M.P. groups.

In the third lamb crop produced by the 1956 born animals in 1960, each treatment group in the S.C.C. breed contained one non-producer, that in the H.P. group being so for the third successive year, as mentioned above. At birth the M.P. group's advantage was due to two pairs of twins compared with the one pair produced in each of the other two groups. Losses increased down the scale of treatment groups resulting in better weaning percentages for the better reared animals.

With no non-producers in any of the N.C.C. treatment groups this year, the differences in percentages of lambs at birth were entirely due to the number of pairs of twins produced. Relatively the same proportion were produced in the H.P. and M.P. groups, namely four pairs and three pairs respectively, while only two pairs were produced in the L.P. group, resulting in a smaller percentage of lambs at birth relative to the other two groups. Similar losses in the H.P. and M.P. groups again resulted in similar weaning percentages, but greater losses in the L.P. group resulted in an even smaller percentage of lambs at weaning.

Born 1957. The 1957 born animals in their first productive year as gimmers in 1959 had non-producers in all treatment groups. While not as numerous as in the 1956 born 1958 season, they nevertheless this year appeared to be all barren ewes and not early abortions. In both breeds, the Hill groups contained the highest percentage of non-producers, with the H.P. group the least in the S.C.C. breed and the M.P. group the least in the N.C.C. breed. As in 1958, there was a tendency for there to be a greater percentage of non-productive ewes in the S.C.C. breed than in the N.C.C. breed.

With three pairs of twins in the S.C.C. H.P. group, one in the M.P. group and none in the Hill group, substantial differences in lambing percentages were present at birth between treatments. In the N.C.C. breed, two pairs of twins in the H.P. group, six pairs in the M.P. group and again none in the Hill group, resulted in even more striking differences between lambing percentages at birth. The M.P. group produced almost 50% more lambs than the H.P. group and almost 100% more than the Hill group.

Fairly heavy lamb losses in the S.C.C. breed, particularly in the M.P. and Hill groups resulted in very low weaning percentages from these groups, being not unlike those obtained from the 1956 born S.C.C. animals in their first lamb crop in a very much harder season. Only in the S.C.C. H.P. group did the weaning percentage remain relatively high. In the N.C.C. breed, similar light losses in the H.P. and M.P. groups, with no losses in the Hill group, resulted in very little difference in weaning percentage between the H.P. and Hill groups, with the M.P. group maintaining a reduced but still substantial advantage.

In the second lamb crop produced by the 1957 born animals in 1960, each

S.C.C. treatment group produced one pair of twins so that the lower lambing percentage at birth in the Hill group was entirely due to its higher percentage of non-producers than that of the H.P. and M.P. groups. With lamb losses being least in the H.P. group and greatest in the Hill group, weaning percentages differed considerably between the treatments in reverse order. In the N.C.C. breed the percentage of non-producers was, as in the S.C.C. breed, higher in the Hill group than in the other two groups. With two pairs of twins in the H.P. and Hill groups and three pairs in the M.P. group, the latter produced the highest percentage of lambs at birth and the Hill group, with more non-producers, produced the lowest percentage. Lamb losses were slightly heavier in the H.P. and M.P. groups and resulted in very little difference in weaning percentages between treatments, only the M.P. group maintaining a slight advantage.

Born 1958. The 1958 born animals in their first productive year as gimmers in 1960 had more non-producers in the S.C.C. Hill group than the corresponding Away group. Neither N.C.C. group contained any non-producers. With no twins in the S.C.C. breed, this gave a slight advantage in lambing percentage at birth to the Away group. By weaning, this difference had disappeared due to a greater loss of lambs in the Away group. In the N.C.C. breed, one pair of twins gave a slight advantage to the Away group in percentage of lambs at birth. Very much heavier losses of lambs in the Away group, however, resulted in a higher weaning percentage in the Hill group.

(b) Lamb losses. From Table 62 it can be seen that differences in percentage losses between treatments varied considerably from season to season. Breed effects and age effects superimposed on season gave results very difficult to interpret within any one lamb crop from any one age group. As lamb losses may vary with the ratio of singles to twins and the latter ratio varies considerably from treatment to treatment, the total percentage losses of both single and twin lambs within groups are given in Table 63. This shows in the S.C.C. breed a close relationship between single lamb losses and general weight

Table 62

Actual lamb losses at birth, between birth and marking and between marking and weaning, with total losses as a percentage of the number of lambs born. Number of lambs born shown in brackets.

		S.C.C.								N.C.C.							
		Born 1956			Born 1957			Born 1958		Born 1956			Born 1957			Born 1958	
		H.P.	M.P.	L.P.	H.P.	M.P.	Hill	Away	Hill	H.P.	M.P.	L.P.	H.P.	M.P.	Hill	Away	Hill
1958 lamb crop	Dead at birth	0(5)	1(6)	1(7)	-	-	-	-	-	1(11)	0(8)	0(8)	-	-	-	-	-
	Birth-marking	2	2	2	-	-	-	-	-	3	1	2	-	-	-	-	-
	Marking-weaning	0	1	0	-	-	-	-	-	1	1	2	-	-	-	-	-
	% total loss	40	67	43	-	-	-	-	-	45	25	50	-	-	-	-	-
1959 lamb crop	Dead at birth	0(5)	0(10)	0(12)	2(11)	1(7)	1(6)	-	-	1(12)	1(10)	0(8)	0(12)	1(17)	0(9)	-	-
	Birth-marking	0	2	2	1	2	2	-	-	0	0	0	1	2	0	-	-
	Marking-weaning	1	1	2	1	1	0	-	-	1	0	0	1	0	0	-	-
	% total loss	20	30	33	36	57	50	-	-	17	10	0	17	18	0	-	-
1960 lamb crop	Dead at birth	1(8)	0(10)	0(11)	0(10)	0(8)	0(8)	1(11)	0(10)	0(14)	0(11)	2(12)	1(12)	2(14)	0(12)	2(16)	0(15)
	Birth-marking	0	3	4	0	2	3	1	2	2	0	1	3	2	2	1	1
	Marking-weaning	0	0	1	1	0	1	1	0	1	2	1	0	0	1	1	0
	% total loss	13	30	45	10	25	50	27	20	21	18	33	33	29	25	25	7

Table 63

Total percentage losses from birth to weaning of single and twin born lambs.

		S.C.C.								N.C.C.							
		Born 1956			Born 1957			Born 1958		Born 1956			Born 1957			Born 1958	
		H.P.	M.P.	L.P.	H.P.	M.P.	Hill	Away	Hill	H.P.	M.P.	L.P.	H.P.	M.P.	Hill	Away	Hill
1958 lamb crop	(Singles	40	67	43	-	-	-	-	-	57	25	33	-	-	-	-	-
	(Twins	-	-	-	-	-	-	-	-	25	-	100	-	-	-	-	-
1959 lamb crop	(Singles	20	25	30	20	60	50	-	-	13	0	0	0	0	0	-	-
	(Twins	-	50	50	50	50	-	-	-	25	25	-	50	25	-	-	-
1960 lamb crop	(Singles	17	17	44	13	17	33	27	20	17	20	38	25	25	13	29	7
	(Twins	0	50	50	0	50	100	-	-	25	17	25	50	33	50	0	-

and condition at the previous November, with the 1956 and 1957 born animals in their first lamb crop losing most lambs from the M.P. groups and least from the H.P. groups. In the N.C.C. breed this is not the case, there being no single lamb losses in the 1957 born first crop, while in the 1956 born first crop the smallest losses were from the highest condition group, namely the M.P., and the greatest losses were rather unexpectedly from the H.P. group.

Subsequent to the gimmer lamb crop, treatment differences seemed to persist in the S.C.C. breed single lamb losses. Both the H.P. and M.P. groups lost fewer lambs than their respective L.P. or Hill group. In the N.C.C. breed, the differences were far more variable with the heaviest losses occurring in the H.P. groups in both the 1956 and 1957 born second lamb crops, although by the 1956 born third lamb crop, the picture had changed to that of the S.C.C. breed, with the smallest losses from the H.P. and M.P. groups.

Where twins were produced, in the S.C.C. breed there was a general loss of some 50% with only in the H.P. groups of the 1956 born third crop and the 1957 born second crop, i.e. the 1960 season, that there was complete survival of twins. In the 1957 born Hill group when it produced its first twin lambs in 1960 there was 100% loss. In the N.C.C. breed, the losses of twins were, as with the singles, difficult to explain, with a general 25 - 50% loss. The only obvious treatment effects were the 100% loss of twins when produced by the L.P. group as gimmers and the smallest losses of twins from the M.P. groups which were in the best condition.

The 1958 born animals in their first lamb crop lost more lambs from the Away groups than the Hill groups, particularly in the N.C.C. breed. This, like the heavier losses from the N.C.C. H.P. groups described above is very difficult to explain but may be a function of the greater number of lambs produced by these groups.

However, the numbers involved in any one group in any one year were small and may give a completely unreal picture purely by chance. To overcome this and to eliminate seasonal effects as far as possible, lamb losses from the three gimmer lamb crops and the three older age lamb crops, in each breed, have been separately totalled and expressed as percentages of the lambs born. Not only have the overall totals been calculated for comparison of age, breed and multiplicity but the individual treatments have also been totalled. In this the 1958 born Away groups have been included with the 1956 and 1957 born H.P. groups and the 1956 born L.P. groups with the 1957 and 1958 born Hill groups. These totals are shown in Table 64. Taking the totals for all lamb crops the first point that appears is that there were considerably heavier losses in the S.C.C. breed than in the N.C.C. This was the case in both single and twin lambs. When the treatments are considered it appears that this difference was due entirely to the M.P. and L.P./Hill reared animals. The H.P./Away animals in both breeds lost similar percentages in both single and twin born lambs while the S.C.C. M.P. and L.P./Hill animals lost considerably more than the respective N.C.C. groups. This was the case in both single and twin lambs. Comparing the effects of treatment on single and twin lamb losses in the two breeds shows that the heaviest losses of twins occurred in the L.P./ Hill groups in both breeds. In the single lambs the range of losses was very much smaller and much more variable between treatments as described above. In general it may be said that the greatest effect of treatment was apparent in the twin lamb losses, where the poorer the treatment the greater was the percentage loss in both breeds, irrespective of the effect on single lamb losses.

When the first lamb crop total percentage losses are separated from those of subsequent crops the first point that emerges is the considerable breed difference between the two when treatment effects are ignored and losses are totalled. In the N.C.C. breed, total losses were the same from both gimmer and older age lamb crops, while in the S.C.C. breed the gimmer lamb crops lost considerably more than the subsequent lamb crops. Heavier losses were experienced in both ages in the S.C.C. breed than in the N.C.C. breed with the

Table 64

Total percentage losses from birth to weaning of single and twin lambs born in three first lamb crops and three subsequent lamb crops.

	1st lamb crops				2nd and 3rd lamb crops				All lamb crops			
S.C.C.	H.P. and Away	M.P.	L.P. and Hill	Total	H.P. and Away	M.P.	L.P. and Hill	Total	H.P. and Away	M.P.	L.P. and Hill	Total
Singles	29	63	35	38	16	20	36	25	23	35	35	31
Twins	50	50	-	50	0	50	67	44	30	50	67	47
Total lambs	33	61	35	40	13	29	42	30	24	39	39	35
N.C.C.												
Singles	27	16	10	18	18	15	16	17	24	15	13	18
Twins	30	25	100	33	32	25	38	31	30	26	50	31
Total lambs	29	20	15	22	23	21	21	22	25	20	18	22

greatest difference occurring in the gimmer age.

Most of the S.C.C. age difference was due to heavier single lamb losses from the gimmers, there being very little difference in twin lamb losses. In the N.C.C. breed, there was no age difference in either singles or twins. In both breeds and all ages, twin losses were greater than single.

When the effects of treatment are considered it becomes apparent that the heavier losses experienced by the S.C.C. gimmer lamb crops were due largely to very much heavier losses in the H.P./Away and M.P. groups than was the case with the older age lamb crops. The L.P./Hill losses in both ages were very similar and in the older ages were the heaviest of the treatment groups. In the N.C.C. breed, there were no treatment differences in the older age lamb crops but in the gimmer lamb crops the H.P./Away losses were the heaviest and the L.P./Hill losses the lightest. This again may be a function of the greater number of twin lambs born to these groups in this breed.

There being very few twin lambs born to the S.C.C. animals, the picture described above for this breed as a whole was also that described by the single lambs. No twins were born to the S.C.C. gimmer L.P./Hill groups and of the few born to the other treatment groups, 50% died, but the numbers were so small that it is not possible to place much importance on this. In the S.C.C. older ages, however, where there were a few more twins, losses ranged from nil in the H.P./Away groups to 67% in the L.P./Hill groups, indicating a long term effect from treatment on the survival rate of twins.

In the N.C.C. breed treatment effects on single lamb losses were very similar to the breed totals described above, with heavier losses from the better reared gimmers but little difference in subsequent ages. Considerably more twins were born to this breed and of those born to gimmers reared on a L.P. or Hill diet, 100% died, compared with 25 - 30% in the other two treatments. In the N.C.C. older ages, treatment differences had almost disappeared, with the L.P./Hill groups losing only slightly more than the other treatments.

In general it may be said that single lamb losses from H.P. and Away reared animals were the same in both breeds; both from gimmers and also from older ages, although of smaller degree in the latter case. In the other treatment groups the S.C.C. animals lost more lambs than the N.C.C. which suggests that the S.C.C. breed as a whole benefited more than the N.C.C. breed from H.P. and Away rearing.

Only in twin lamb losses were the effects of treatment consistent with the degree of treatment regardless of breed and in the comparison of different treatments it seems certain that the first symptom of any significance that should be looked for is a decrease in the percentage of twin lamb losses with improved rearing. This also appears to have a long term effect beyond the first lamb crop.

In Table 62 the lamb losses occurring during different periods of the first fifteen weeks of life are shown. It is not intended to elaborate on this as the numbers involved were small but the general picture is as follows. At least 50% of losses occurred between birth and marking and most of these occurred within a day or two of birth. Treatment effects were absent in the N.C.C. breed but S.C.C. animals on M.P. and L.P./Hill rearing lost many more lambs during this period, largely on account of failure to develop sufficient mammary tissue and produce milk as gimmers, with their lambs as a result dying from starvation.

(c) Lamb weights.

Birth. Mean weights of single and twin lambs at birth in the different treatment groups are shown in Table 65. Males and females being in fairly even proportions have been grouped together. Analysis of variance was carried out on both single and twin lambs. Single lamb weights differed between treatments by varying amounts up to just under 2 lb. but no significant differences existed in either breed in any age or year. This was the case also in twin lamb weights with one exception, the S.C.C. 1957 born second

Table 65

Mean weights of single and twin lambs at birth (lb.)
Number of lambs in brackets.

		Born 1956			Born 1957			Born 1958	
		H.P.	M.P.	L.P.	H.P.	M.P.	Hill	Away	Hill
S.C.C.									
1958 lamb crop	Singles	6.8(5)	5.6(6)	6.9(7)	-	-	-	-	-
	Twins	-	-	-	-	-	-	-	-
1959 lamb crop	Singles	8.2(5)	8.2(8)	8.3(10)	7.0(5)	7.7(5)	7.4(6)	-	-
	Twins	-	6.6(2)	6.3(2)	5.2(6)	4.4(2)	-	-	-
1960 lamb crop	Singles	9.5(6)	7.7(6)	7.9(9)	7.5(8)	6.6(6)	8.7(5)	7.5(11)	7.5(10)
	Twins	6.8(2)	6.1(4)	5.3(2)	4.6(2)**	6.8(2)*	8.3(2)	-	-
					*** (H.P. vs Hill)				
N.C.C.									
1958 lamb crop	Singles	6.4(7)	7.0(8)	6.0(6)	-	-	-	-	-
	Twins	5.6(4)	-	6.3(2)	-	-	-	-	-
1959 lamb crop	Singles	9.3(8)	9.4(6)	10.3(8)	8.8(8)	9.5(5)	8.0(9)	-	-
	Twins	8.0(4)	6.4(4)	-	6.3(4)	5.5(12)	-	-	-
1960 lamb crop	Singles	10.3(6)	10.2(5)	8.5(7)	9.0(8)	8.7(8)	8.6(8)	8.0(13)	8.3(13)
	Twins	6.5(8)	6.7(6)	6.8(4)	6.5(4)	6.4(6)	6.8(4)	5.6(2)	-

*** = Significant at the 0.1% level of probability.
** = " " " 1% " " "
* = " " " 5% " " "

lamb crop in 1960 produced one pair of twins in each treatment group which were significantly different in weight in an ascending order of heaviness from H.P. through M.P. to Hill. This may however be ignored, being only one pair in each case.

Marking. With birth dates ranging mostly over three weeks and marking being carried out at a mean six weeks of age it was decided that a more accurate picture of marking weights would be obtained if they were adjusted to a standard age. This was carried out in one of the ways described by Warwick and Cartwright (1958), namely, adjusted marking weight = (gain per day from birth to true marking x standard age in days) + birth weight. The standard age used was 32 days, this being the difference between the mean date of birth and the date of marking.

These adjusted marking weights are shown in Table 66 for both single and twin lambs. In general, differences between treatments were not great and variance analysis demonstrated no significance.

Weaning. This took place at a mean 15 weeks of age. Birth date differences were of much smaller proportion relative to the total age at weaning compared with that at marking. On this account the regression of weaning weight on birth date was calculated for three different sample age groups. Being non-significant in every case, differences in birth date have been ignored in comparing unadjusted weaning weights. These are shown in Table 67. As with birth and marking weights, none of the differences between treatments were significant when tested by analysis of variance.

(d) Milking ability of ewes. From birth to marking the lamb is almost entirely dependent on its mother's milk for existence. From this it may be assumed that the gain from birth to marking is an index of the ewe's milk production. As nursing twin lambs induces greater milk flow than only one lamb (Davies, 1958; Alexander and Davies, 1959), where this was the case the total gain of the pair may also be assumed to be an index of the ewe's milk

Table 66

Mean weights of single and twin reared lambs at marking adjusted to 32 days of age (lb.). Number of lambs in brackets.

		Born 1956			Born 1957			Born 1958	
		H.P.	M.P.	L.P.	H.P.	M.P.	Hill	Away	Hill
S.C.C.									
1958 lamb crop	Singles	18.8(3)	12.4(1)	14.1(3)	-	-	-	-	-
	Twins	-	-	-	-	-	-	-	-
1959 lamb crop	Singles	27.2(5)	24.8(8)	26.4(10)	21.6(6)	24.2(5)	24.1(3)	-	-
	Twins	-	-	-	19.0(2)	-	-	-	-
1960 lamb crop	Singles	23.4(6)	20.8(7)	22.8(7)	20.0(8)	18.6(6)	20.4(4)	20.4(9)	18.8(8)
	Twins	-	-	-	18.0(2)	-	-	-	-
N.C.C.									
1958 lamb crop	Singles	20.1(3)	18.7(7)	18.8(3)	-	-	-	-	-
	Twins	16.1(4)	-	18.4(2)	-	-	-	-	-
1959 lamb crop	Singles	29.6(7)	28.5(7)	30.1(8)	25.1(9)	27.5(9)	26.6(9)	-	-
	Twins	22.8(4)	21.7(2)	-	16.6(2)	20.6(2)	-	-	-
1960 lamb crop	Singles	26.5(6)	28.5(5)	27.6(6)	23.0(7)	25.9(9)	23.9(10)	23.7(12)	21.7(12)
	Twins	19.9(6)	18.6(6)	15.0(2)	-	-	-	-	-

Table 67

Mean weights of single and twin reared lambs at weaning at 15 weeks of age (lb.). Number of lambs in brackets.

		Born 1956			Born 1957			Born 1958	
		H.P.	M.P.	L.P.	H.P.	M.P.	Hill	Away	Hill
S.C.C.									
1958 lamb crop	Singles	36.0(3)	32.0(1)	33.3(3)	-	-	-	-	-
	Twins	-	-	-	-	-	-	-	-
1959 lamb crop	Singles	57.0(4)	50.1(7)	51.8(8)	46.2(5)	46.0(3)	50.0(3)	-	-
	Twins	-	-	-	34.5(2)	-	-	-	-
1960 lamb crop	Singles	51.3(6)	46.1(7)	52.7(6)	42.7(7)	43.0(6)	48.3(4)	40.9(8)	42.4(8)
	Twins	-	-	-	42.0(2)	-	-	-	-
N.C.C.									
1958 lamb crop	Singles	49.5(2)	39.2(6)	42.8(4)	-	-	-	-	-
	Twins	39.0(3)	-	-	-	-	-	-	-
1959 lamb crop	Singles	59.7(7)	62.1(7)	58.9(8)	54.3(8)	56.1(9)	54.3(9)	-	-
	Twins	43.3(3)	47.0(2)	-	39.0(2)	47.5(2)	-	-	-
1960 lamb crop	Singles	60.6(7)	58.8(4)	58.8(6)	51.5(6)	59.8(9)	54.6(9)	52.2(10)	46.8(14)
	Twins	50.5(4)	50.4(5)	43.5(2)	-	-	-	-	-

production. From the calculation of adjusted marking weights (above) it was possible to obtain the gain in lamb weight to 32 days of age. This is shown in Table 68. Considering this as pounds of milk produced by each nursing ewe it appears that the treatments have created differences in yield in direct relation to the level of rearing. In the S.C.C. breed the H.P. and Away animals consistently produced more milk than the other treatment groups in the first and second productive years. This was the case in the 1957 born 1959 lamb crop only on account of one H.P. gimmer nursing twins. The over 2 lb. advantage held by the same H.P. group in the 1960 lamb crop was also due largely to one pair of twins being nursed.

In the N.C.C. breed the 1956 born L.P. group appear to have consistently produced less milk in each of the three lamb crops than the H.P. group, with the M.P. group producing the least in the gimmer year, an intermediate amount in the second year and the most in the third year. However, these differences were almost entirely due to the variable number of pairs of twins being nursed in the different groups. In the 1957 born age group, the M.P. animals in both the first and second years produced the most milk of the three treatments and the H.P. animals produced the least. One pair of twins being nursed in each of the H.P. and M.P. groups in the gimmer year had little effect on these relative differences. In the 1958 born age group, the Away wintered animals produced almost $2\frac{1}{2}$ lb. more milk in the gimmer year than the Hill animals, with only single reared lambs.

All differences between treatment yields were tested by analysis of variance but none reached significance in either breed.

(e) Ewe lambs retained for stock replacement. The number of ewe lambs available at weaning and the number of ewe lambs retained in each treatment group are shown in Table 69. In general the numbers in any one group were small so the three gimmer lamb crops and the three older age lamb crops have been grouped together and the total ewe lambs retained are shown as percentages

Table 68

Gain in weight of lamb from birth to 32 days as a measure of the milking ability of the ewes (lb.)
Number of ewes in brackets.

	Born 1956			Born 1957			Born 1958	
	H.P.	M.P.	L.P.	H.P.	M.P.	Hill	Away	Hill
S.C.C.								
1958 lamb crop	11.8(3)	6.2(1)	7.5(3)	-	-	-	-	-
1959 lamb crop	19.0(5)	16.7(9)	17.7(11)	16.6(7)	16.5(5)	14.2(6)	-	-
1960 lamb crop	14.3(7)	13.3(7)	14.9(7)	14.1(9)	11.9(6)	11.8(4)	12.7(11)	11.4(8)
N.C.C.								
1958 lamb crop	16.1(5)	11.6(7)	14.9(4)	-	-	-	-	-
1959 lamb crop	22.2(9)	20.6(8)	19.9(8)	17.2(10)	20.8(10)	18.7(9)	-	-
1960 lamb crop	20.2(9)	20.4(8)	18.0(8)	14.5(7)	17.6(9)	15.9(10)	15.9(12)	13.5(12)

Table 69

Number of ewe lambs retained for stock replacement in each group from the number of ewe lambs available at weaning.

S.C.C.

	Born 1956 H.P.	Born 1956 M.P.	Born 1956 L.P.	Born 1957 H.P.	Born 1957 M.P.	Born 1957 Hill	Born 1958 Away	Born 1958 Hill
1958 lamb crop	0-0	0-1	0-1	-	-	-	-	-
1959 lamb crop	1-1	2-3	3-3	0-1	1-2	1-2	-	-
1960 lamb crop	1-3	0-2	5-5	2-6	0-2	1-1	1-4	3-5
Totals	2-4	2-6	8-9	2-7	1-4	2-3	1-4	3-5

N.C.C.

	Born 1956 H.P.	Born 1956 M.P.	Born 1956 L.P.	Born 1957 H.P.	Born 1957 M.P.	Born 1957 Hill	Born 1958 Away	Born 1958 Hill
1958 lamb crop	0-2	0-4	1-4	-	-	-	-	-
1959 lamb crop	1-5	3-3	2-3	1-5	2-9	1-2	-	-
1960 lamb crop	3-6	3-7	2-6	2-3	1-4	2-6	1-7	2-9
Totals	4-13	6-14	5-13	3-8	3-13	3-8	1-7	2-9

in Table 70. From both the above Tables it is apparent that in the gimmer lamb crops in both breeds the highest percentage of ewe lambs retained was from the L.P./Hill groups. In the older age lamb crops this was still the case in the S.C.C. breed, with, in fact, 100% retention, but in the N.C.C. breed there was little difference between treatments with the L.P./Hill being just the lowest.

When the breed totals are examined it is striking how the S.C.C. H.P./Away and M.P. treatments and all three N.C.C. treatments provided very similar percentages of ewe lambs retained, namely approximately 30%, while the S.C.C. L.P./Hill groups provided $2\frac{1}{2}$ times this figure. This is difficult to explain, particularly as it is not due to any shortage in number of ewe lambs available in the L.P./Hill groups nor to a greater number of twins in the other treatment groups, there being only two twins available in a total of 42 ewe lambs in the S.C.C. breed. In the N.C.C. breed, there were 14 ewe twins in a total of 85 lambs available, with only 2 in the L.P./Hill groups and with no twin being retained, a completely different picture arises. The twins in the H.P./Away and M.P. groups probably to a certain extent lower the percentage of ewe lambs retained in these groups relative to the L.P./Hill groups.

A possible explanation for these breed differences may be found in examination of the percentage of lamb losses between birth and weaning shown in Table 62. In the S.C.C. breed the heaviest losses occurred in the L.P./Hill groups which may have meant that with the poorer lambs dying, the survivors were probably of higher standard and more likely to be suitable for retention. In the N.C.C. breed, however, the lightest losses occurred in the L.P./Hill groups and with the subsequent survival of a large number of smaller, poorer lambs, the percentage suitable for retention would probably be much smaller than in the S.C.C. breed.

(f) Discussion on lamb production. With small numbers in each treatment group initially and the removal of two average animals per group for dissection

Table 70

Percentage of ewe lambs retained in three gimmer lamb crops and three older age lamb crops.

		H.P./Away	M.P.	L.P./Hill
3 Gimmer lamb crops.	S.C.C.	20	33	50
	N.C.C.	14	15	27
3 Older age lamb crops.	S.C.C.	40	29	100
	N.C.C.	47	50	40
S.C.C. Total		33	30	77
N.C.C. Total		29	33	30

making for a greater relative range of individual variation, the results from lamb production records can be no more than trends on which future studies may be based. In this report life time production cannot be included so the effects of treatment have been studied on gimmer lamb crops for each experimental year and on as many subsequent lamb crops as it has been possible to include. In the preceding sections the individual years have been discussed and in certain aspects the years have been grouped in an attempt to eliminate seasonal effects and to increase the size of the treatment units.

In Table 71 this has been done for the percentages of non-productive ewes, lambs born and lambs weaned. This shows in both breeds a smaller percentage of non-productive gimmers resulting from H.P./Away rearing, with no difference between the other two treatments. In all treatment groups the S.C.C. breed contained a greater percentage of non-producers than the N.C.C. breed. This breed difference had largely disappeared by the second lamb crop, the percentage of S.C.C. non-producers dropping a greater extent than that of the N.C.C. breed. Treatment differences persisted in the N.C.C. breed and may well have done so in the S.C.C. breed apart from the one H.P. group in the 1956 born 1959 lamb crop discussed in the section on that age group.

In the gimmer age groups, the treatments have had the desired effect of increasing with better rearing the percentage of lambs born in both breeds. By weaning, the percentages of lambs still alive in the different treatment groups were more closely related to the condition of the gimmers at their first mating at 18 months of age than to their condition at the end of the treatment period at 12 months. In other words, while treatment effects may certainly create differences, it is the summer environment subsequent to treatment superimposed upon the treatment differences that results in variations in gimmer lambing performance.

In subsequent lamb crops the percentages of lambs born in both breeds and all treatment groups (with one exception) were higher than in the gimmer lamb

Table 71

Percentages of non-productive ewes, lambs born and lambs weaned in three first lamb crops and three subsequent lamb crops.

	1st lamb crops			2nd and 3rd lamb crops		
	H.P./Away	M.P.	L.P./Hill	H.P./Away	M.P.	L.P./Hill
S.C.C.						
Non-productive ewes	23	29	30	19	8	10
Lambs born	87	76	69	88	108	103
Lambs weaned	58	29	45	77	77	58
N.C.C.						
Non-productive ewes	11	17	16	3	7	13
Lambs born	103	109	86	123	121	100
Lambs weaned	74	87	73	94	97	78

crops. The exception being the S.C.C. H.P./Away groups, on account of the 1956 born 1959 lamb crop discussed above. Treatment effects were still present in the N.C.C. breed with the L.P./Hill groups producing fewer lambs than the other two treatments. This would almost certainly have been the case also in the S.C.C. breed if it were not for the above mentioned exception. The breed difference present at birth in the gimmer ages had disappeared in the older age L.P./Hill groups but was still present in the other two treatments. By weaning this breed difference had reappeared in the L.P./Hill groups and was still present in the other treatments.

In both breeds, treatment effects to some extent appear to have persisted beyond the gimmer year in terms of percentages of lambs weaned, the L.P./Hill groups weaning almost 20% fewer lambs than the other two treatments. No difference existed between the H.P./Away and M.P. groups in either breed. The percentages of lambs weaned in the older age L.P./Hill groups did not differ greatly from those weaned in the same groups as gimmers, particularly in the N.C.C. breed, compared with the other treatments. From this it might be inferred that the better rearing treatments have a greater effect on lamb production after the first year than they do in the first year. This point requires several years more study to counteract seasonal variation and the small size of the experimental groups.

It is obvious that the end product of lamb production, namely the number of lambs weaned, is the nett result of a complex of interacting factors. These are the number of barren or non-productive ewes, the number of twin lambs born and the number of lambs dying at birth and between birth and weaning. The effects of different treatments on these various factors and the relationships between them have been discussed throughout the previous sections with regard to the individual experimental years and also the different age groups.

In general the effects of improved rearing, particularly H.P., on gimmer lamb production appear to be a reduction in the number of barren or non-productive ewes and an increase in the number of twin births. The degree of improvement undoubtedly plays a part, there being virtually no difference between the M.P. and L.P./Hill groups in the percentage of barren or non-productive ewes. The increase in the number of twin births was probably brought about by the earlier maturity of the better reared animals causing them to come more quickly to the ram in their first breeding season than their later maturing L.P. and Hill sisters. The effects of treatment on lamb losses are varied and difficult to interpret, there being an apparent interaction between the number of lambs born and the number dying, with the result that in the gimmer year, where treatments have produced more lambs, namely twins, there has been a tendency for heavier losses. There is also the possibility that certain animals have produced and failed to rear a lamb after better rearing when had they not received better rearing they might not even have produced.

Season also plays a part in the survival rate of gimmers' lambs, as in a severe season the losses of lambs appear to have been directly proportional to the condition of the gimmers at mating, while in a good season this may have been overshadowed by other factors. Breed differences were considerable, particularly in a good season, e.g. 1959, where the S.C.C. losses tended to follow a similar pattern to that of the 1958 bad season, while the N.C.C. losses were more closely related to the number of twins born.

The effects of treatment were very distinct on twin lamb survival. Where twins were born to L.P. or Hill reared gimmers there was 100% loss but when born to one of the better reared treatment groups the loss was only from 25 - 50%. Single lamb losses in general followed the pattern of total losses and at no time showed such a distinct variation with treatment as was exhibited by the twin lamb losses.

The effects of treatment on lamb production subsequent to the gimmer year appear to have persisted into the 2nd and even the 3rd year. The pattern has, however, changed slightly in that with residual effects from the first year's production creating differences in condition at mating, the percentage of barren ewes, while much smaller, was distinctly varied between treatments. Nevertheless, there was still a tendency for the greatest percentage to occur in the L.P./Hill reared groups, with the M.P. performance swinging towards that of the H.P./Away groups.

In the older age lamb crops, the better reared treatment groups still produced more twin lambs which also had a greater chance of survival than the twins produced by the L.P./Hill groups. Only in the S.C.C. breed did treatment effects persist in single lamb losses after the first lamb crop, with the lightest losses from the H.P./Away groups and the heaviest from the L.P./Hill groups. In general, lamb losses in the L.P./Hill groups were very similar in both gimmer and subsequent ages while in the other treatment groups the gimmer's lamb losses were heavier than those of the older ages. In other words it appears that while improved rearing may produce variable results in lamb losses in the gimmer year it reduces the losses in subsequent years relative to the unimproved rearing and by so doing provides further evidence to support the inference discussed earlier that the better rearing treatments have a greater effect on lamb production after the first year than they do in it.

Weights of lambs, both single and twin, at birth, marking and weaning showed tendencies of responding directly to treatment both in the first and subsequent lamb crops but small numbers and considerable variation made the demonstration of significance impossible. This also applied to milk production as described by lamb growth between birth and 32 days of age, the presence of twin nursed lambs creating most of the differences between treatments.

(g) Summary of lamb production.

1. A greater percentage of barren or non-productive ewes in the S.C.C. gimmers' lamb crop than in that of the N.C.C. breed. This difference had disappeared by the second lamb crop but this may be due to seasonal variation.

2. H.P. and Away treatments reduced the number of barren or non-productive ewes relative to the other treatments in the first lambing year. No difference between the other treatments. In subsequent years, less obvious and diminished treatment differences persisting, particularly in the N.C.C. breed.

3. Increase in lambing percentages at birth in H.P., Away and M.P. groups in gimmer year, due to reduced numbers of barren ewes and also increased numbers of twin births. This situation repeated in 2nd and 3rd lamb crops.

4. Weaning percentages entirely due to relationship between lambs born and lamb dying. A very close relationship between lamb losses, weaning percentage and condition of the ewe at mating at 18 months of age. Summer environment post-treatment, from 12 - 18 months, and the subsequent winter environment, have a very great influence on the response to treatment of the first lamb crop. Later lamb crops, while also partially dependent on mating condition, are not so strikingly affected by extreme seasonal variation as are the first crops.

5. A reduction in twin lamb losses with improved rearing, both in gimmer and subsequent lamb crops. Single lamb losses less affected by treatment than twin lamb losses. A breed difference apparent here.

6. Smallest weaning percentages from L.P. and Hill reared groups in 2nd and 3rd lamb crops.

7. Too many external factors interfering with response to treatment in the first lamb crop, resulting in the suggestion that the treatments have a limited but more positive effect on lamb production after the first year rather than during it.

8. No significant differences between treatments in either breed in any year, of lamb weights at birth, at adjusted marking at 32 days or at weaning, nor of lamb gain over 32 days from birth as a measure of milking ability.

9. Considerably more ewe lambs were retained from the S.C.C. L.P. and Hill groups than from any other treatment in either breed. Possible explanations for this are discussed.

GENERAL DISCUSSION AND CONCLUSIONS

In a study of this nature involving several different aspects of a main theme and each receiving examination of a detailed and complex nature, it has been considered inadvisable to leave all the discussion to a final section. For this reason each aspect has been discussed in turn during the examination of results section and it is now only intended to interrelate the various aspects in as much as together they make up the whole, from which conclusions as to the trends occurring and likely to occur may be drawn.

Basically this is two studies, firstly it is a study of the effect of different levels of winter feeding on the growth and development of North and South Country Cheviot ewe hoggs and secondly it is a study of the productivity of these animals in their productive years as affected by the differences in growth and development created by treatment.

In the General Introduction it was stated that hill wintered hoggs lose, on average, 7 lb. (or 10 per cent) in weight over the winter on Sourhope farm. This then was the base line upon which the experiment was designed, with the object of comparing the growth, development and performance of animals so wintered with that of animals which received different levels of improved wintering. In the 1956 born age group the treatment period was from 27 - 49 weeks, during which time an artificially fed L.P. diet achieved the required drop of 7 lb. (10%) in weight and a M.P. diet maintained weight, producing a 7 - 9 lb. (11 - 13%) difference between these treatments, while a H.P. diet produced a 21 - 22 lb. (34 - 35%) difference between this treatment and the L.P. treatment. In the 1957 born age group a five weeks earlier start was made to the treatment period which ran from 22 - 49 weeks. Naturally hill wintered hoggs lost 6 - 10 lb. (10 - 15%) during this time, a M.P. diet created a slight gain in weight, producing a 10 - 14 lb. (18 - 24%) difference between these treatments, while a H.P. diet produced a 26 - 34 lb. (47 - 57%) difference between this treatment and the Hill treatment. In the 1958 born age group the treatment period was from 25 - 49 weeks and the hill wintered hoggs this year actually gained slightly in weight, emulating the M.P. treatment in the previous year, while the Away treatment only produced a 6 - 7 lb. (9 - 12%) advantage over the Hill treatment.

In terms of body size as depicted by the changes occurring in seven live measurements, four body and three leg, the 1956 born H.P. hoggs at the end of the treatment period were on average 7 - 8% larger than the L.P. hoggs in all dimensions, while the M.P. hoggs were 2 - 4% larger. In the 1957 born age group the H.P. hoggs were 9 - 10% larger than the Hill hoggs, while the M.P. hoggs were 3 - 4% larger. In the 1958 born age group the Away hoggs were 5% larger than the Hill hoggs. These are the mean differences between the treatments in the seven measurements and as body measurements were generally more affected by treatment than leg measurements, body size differences were in fact greater than these figures indicate. Also, with all except girth being straight measurements, the volume of the body obviously increases by very much more than appears from these figures.

A weakness in this study is undoubtedly the check which occurs in growth and development when introducing the hoggs to a shed environment and to a change in diet, a check which does not occur with natural hill wintering. While rapidly overcome during the second half of the winter it is by no means certain that skeletal growth and development has not been affected in a manner disimilar to that occurring in hill wintered hoggs. However, if this is the case, it is not obviously apparent from the live measurements nor from the bone dissections when comparing the 1956 born L.P. animals with the 1957 born Hill animals.

Live weight is a complex of organs and tissues and while treatment effects have been demonstrated on the early developing organs and bone, the greatest differences have been created in the later developing muscle and latest developing fat. A great deal of the difference in weight between the treatment groups was undoubtedly caused by the presence or absence of this latter tissue.

However, bone growth has undoubtedly been increased by both the H.P. and M.P. diets relative to the L.P./Hill diets over the treatment period and it is this greater skeletal frame which, if it persists, will ultimately influence future survival and production.

It is apparent from the results that response to treatment is closely related to the stage of growth reached by the animals just prior to treatment. This is particularly obvious from the study of growth and development in the heavy and light hoggs at that time, the light hoggs generally responding more to H.P. and M.P. diets and suffering less on L.P./Hill diets than the heavy hoggs.

Having achieved considerable differences between the treatment groups in weight and size at the end of the treatment period, interest then centres on the persistence of these differences in subsequent life under what is considered to be a uniform environment for all animals. I say "considered to be" advisably in view of the findings of a research team from the Hill Farming Research Organisation which is currently studying grazing pressures and behaviour patterns of sheep on hill pastures, which suggest that the hill may not be such a uniform environment for all as it is believed to be. However, until such possible differences can be measured it must be assumed that within any one experimental group the differences will cancel out.

Over the summer after treatment it has been shown that there is a strong interaction between the stage of growth and development reached by 12 months and the summer season or environment on the response of the treatment groups in terms of weight and size increase. As the stage of growth and development at 12 months was shown above to be due to an interaction between treatment and the stage of growth and development prior to treatment which was related to the environment or season during the animal's first six months of life, it becomes apparent that the situation at 18 months is subject to a considerable number of variables. From this it is possible to liken the first 18 months of life in hill sheep to a series of three treatment periods of roughly 6 months duration each, with season being the controlling factor in each case. A series of adverse seasons are therefore likely to have a very restricting effect on growth and development, while variations in seasonal effects may likewise create differences in size and weight at 18 months which might have far reaching consequences in future survival and productivity. It is therefore suggested that research into these seasonal interactions on a broader and more critical basis than in this study may be of considerable value.

Between 12 and 18 months in this experiment the differences between treatments in weight and size were generally greatly reduced. Between the H.P. and L.P. animals in the 1956 born age group at 18 months there was still a difference of 10 - 11 lb. (11%) in weight and 3 - 4% in mean live measurement; between the H.P. and Hill animals in the 1957 born age group the differences were greater, being still 12 - 16 lb. (14 - 17%) in weight and 4 - 5% in mean live measurement; and between the Away and Hill animals in the 1958 born age group there was only a difference of 4 lb. (4%) in weight and 1 - 2% in mean live measurement. In the first two age groups these differences were still significant in weight and in the body measurements but significance was tending to disappear in the leg measurements. The differences between these treatments in weight were further reduced over the second winter of life but remained significant until two years of age, after which differential productivity introduced too great a variability for significance to be demonstrated. With minor exceptions, significance had also disappeared from the differences in live measurements by 27 months, although there was still a 2 - 3% mean difference.

In spite of this failure to create permanently significant differences in weight and size after 2 years of age it must be stated that in appearance the H.P. animals were still larger framed than the L.P. or Hill animals at the time of writing, when the 1956 born age group were six years of age and it is therefore suggested that H.P. rearing of the standard here employed does develop a larger animal than traditional hill wintering. This, however, is not necessarily an advantage after the first productive year as the greater size may become a limiting factor in a severe environment under fixed stocking. The differences in weight and size between the 1958 born Away and Hill wintered animals completely disappeared after 18 months but as neither treatment was extreme this is not an unexpected result.

The response of the M.P. wintered animals in the first two age groups relative to the other treatments is of considerable interest in subsequent life. In the N.C.C. breed in both years they rapidly approached the H.P. animals in weight at 18 months and by so doing they were still 10 - 11 lb. (10 - 11%) heavier than the L.P./Hill animals at this time and 1 - 3% larger in mean live measurement. After 18 months they continued to show greater response than the other treatment groups and became the heaviest in their breed, a result which persisted up until the time of writing. They also maintained a 2% advantage in mean live measurement to 39 months of age, which possibly still exists. In the S.C.C. breed, however, the M.P. animals gave an entirely different result, responding very much less than the L.P./Hill animals and becoming as light as the latter at 18 months in the 1956 born age group but being a year later in the 1957 born age group in this respect. After 18 months in the former age group they became the lightest in their breed but in the latter age group the more extreme treatments appear to have maintained them at roughly the same weight as the Hill animals. In mean live measurement there was still a difference of 1% at 39 months of age.

This breed difference is very difficult to understand but it may be explained by the incompatability of the two breeds when run together on the same piece of hill. Observations on the behaviour of these breeds have indicated a psychological inferiority in the S.C.C. breed when grazing the same hill as the N.C.C. breed, with the result that they graze the poorest herbage and their performance is correspondingly adversely affected. For this reason breed comparison after treatment has been generally avoided in this study, any such comparison of subsequent response being of doubtful validity.

It is therefore suggested that the N.C.C. picture of weight change is a more accurate measure of the response to treatment and that M.P. rearing may be as good if not better than H.P. rearing and certainly better than traditional hill wintering of average severity on ultimate body size and weight. This result seems to bear out Fraser's (1937) suggestion that it is possible to spoil ewe hoggs in their first winter by doing them either badly or too well, an error in either direction being reflected in the ewe stock for years thereafter.

Within the total treatment groups the relative responses of the heavy and light animals prior to treatment have been studied in subsequent life. Although there were exceptions, in general the effects of treatment were greater and more persistent in the light animals than in the heavy in both weight and size as depicted by the live measurements. At 18 months the treatment differences were generally greatly reduced in the heavy animals and no longer significant in weight or as consistently significant in the live measurements as in the light animals. Treatment differences in the latter tended to persist significantly to two years of age and were still sizable as far as these records go, while in the heavy animals they had virtually completely disappeared by 30 months. The light hoggs L.P. or Hill wintered were largely responsible for the above picture, being so retarded in growth by 12 months of age after the treatment period that they were beyond recovery in terms of size and weight, unlike the heavy hoggs so wintered, which had achieved sufficient growth prior to treatment to be able to recover during later life from their sub-optimum wintering.

H.P. wintering of light hoggs, while making them heavier and larger than heavy hoggs L.P./Hill wintered at 12 months and being still as heavy and as large at 18 months, failed to maintain this situation after this time, largely due to the greater residual potential for growth and development inherent in the heavy animals. In general, regardless of treatment the heavier animals at 6 months remained so throughout their life and actually increased their advantage in weight and size over the light animals with advancing age, showing greater potential in the later stages of growth than the latter. Treatment, however, does have some influence in reducing this difference but failed to overcome it completely. It is therefore suggested that light animals at 6 months of age are beyond the stage of growth where improved wintering can overcome the deficit and greater attention to growth during the first 6 months of life may be of more advantage to the farmer than expensive wintering treatments.

Treatment has been shown to have a considerable effect on the time of eruption of the permanent incisor teeth. H.P. wintering resulted in eruption starting at approximately 12 months, anything up to two months earlier than from L.P. or Hill wintering, with that from M.P. wintering only very little earlier than from the latter. The earlier start to the treatment in 1957 also appears to have resulted in earlier eruption in the H.P. animals born that year than was the case in the 1956 born H.P. animals. It is suggested that this is indicative of earlier maturity in the H.P. wintered animals, making them physiologically older than the L.P./Hill animals at the same chronological time. Treatment effects appear to persist in the eruption of the subsequent pairs of permanent incisor teeth, although reduced in magnitude, probably due to the considerable individual variation that exists in the time of eruption of all incisors after the first pair.

Treatment effects appear to be more pronounced on the eruption of the first pair of incisors in the heavy hoggs than in the light hoggs. H.P. and M.P. wintering inducing earlier eruption in the heavy hoggs than L.P./Hill wintering, while in the light hoggs only H.P. wintering had a limited effect, with M.P. and L.P./Hill wintering inducing similar times of eruption as in the heavy hoggs L.P./Hill wintered. This further suggests the relative immaturity of the light hoggs at 6 months compared with the heavy hoggs and their inability to respond as much to treatment as the latter.

Although no signs of dental breakdown have appeared by the time of writing, it is suggested that the earlier eruption resulting from H.P. wintering in particular, may lead to earlier breakdown due to earlier maturity and longer attrition of the teeth, with the resultant possibility of reduced value as draft ewes.

The mortality rate was generally small in this experiment but of the ewes dying between 6 and 30 months from natural causes, i.e. metabolic disorders or infectious diseases, 40% were H.P. and Away wintered, 46% were M.P. wintered and only 14% were L.P. and Hill wintered, all relative to the numbers in each treatment. The actual percentage losses were 8.3% from the H.P./Away animals, 9.5% from the M.P. animals and 2.8% from the L.P./Hill animals. Deaths were therefore greater in number from those animals which received a higher standard of winter feeding, with the high M.P. percentage largely due to the N.C.C. animals which had become the largest in their breed after 18 months. It is therefore suggested that the upset of artificial wintering treatments coupled with earlier maturity and the larger size achieved predispose to a greater likelihood of premature loss through lowered resistance to the stresses of sub-optimum wintering, particularly in the larger N.C.C. breed. This poses the question of size being a possible factor in the survival of hill sheep and introduces the suggestion that youth or immaturity may be a prerequisite for resistance to stress and efficient productivity during a normal hill productive life, while forcing in early life with resultant earlier maturity may predispose to lowered efficiency with age and a shortening of the productive life.

Treatment effects were generally considerable on wool clip in the first year, with the check resulting from changes in habitat and diet in the H.P. and M.P. animals probably reducing the degree of difference relative to unchecked Hill animals. After the first year, treatment effects tended to be greatly reduced, with the greater yield possible from the larger bodied H.P. and M.P.

animals generally being restricted by their greater lamb production relative to the smaller less productive L.P./Hill animals. Season appears to have an influence on the persistence of treatment effects, possibly by its action on the relative productivity of the different groups. It is therefore suggested that while treatment creates considerable differences in wool yield in the first year, subsequent clips are more closely related to the level of lamb production in the previous year than to treatment, except in so far as treatment has created these differences in lamb production.

The greater development of the reproductive organs in the H.P. animals demonstrated by dissection resulted in a reduction in non-productive gimmers compared with the other two treatments. This, along with a greater number of twin births in the H.P., Away and M.P. animals, created larger lambing percentages at birth relative to the L.P./Hill animals. Losses of lambs in the gimmer year appeared to be closely related to the season, the number of lambs produced, particularly twins, and the condition of the gimmers at 18 months. It is therefore suggested that the percentage of lambs weaned in the first productive year will show a greater response to treatment in a severe season, the greater condition of the H.P., Away and M.P. animals enabling them to produce and nurse a lamb more efficiently than the L.P./Hill animals, while in a good season the latter will be less likely to be limited in production as they would under sub-optimum conditions. Later lamb crops, although also affected to a limited extent by season and condition at mating, do not show such extreme variations as gimmer lamb crops and the treatment effects, while reduced in magnitude, appear to be more positive after the first year than during it. However, only three lamb crops have been recorded in the oldest age group in this thesis and it is therefore not possible to comment on the long term effects of treatment on lamb production. In general, it can be stated that improved wintering reduces barrenness, increases twin births and depending on season, may reduce lamb losses but this is not conclusively demonstrated as it seems probable that with the greater number of lambs produced, particularly twins, some are of poor standard and will not survive. This lowering of the overall standard of single lambs as well as twins is further emphasised by the retention of relatively fewer ewe lambs for replacement from the improved wintering treatments. It is also suggested that treatment effects are greatest on the number of lambs produced and reared with virtually no effect on lamb weight or milking ability of the ewe.

The conclusion to be drawn from this experiment is that hill wintering of average severity as experienced on Sourhope farm retards growth and can, depending on seasonal effects both before and after the first winter, permanently restrict development with resultant poorer production in the first productive year and probably also in the second and third productive years. M.P. or maintenance wintering is therefore recommended as being as good if not better than H.P. wintering and certainly much cheaper, with greater growth and more efficient production than from average traditional hill wintering. Away wintering is expensive and may not give much better results than M.P. wintering, while a very good winter on the hill in 1958-59 created very little difference and made comparison impossible in that year. The earlier start to the treatment period in 1957 created greater differences after treatment but the advantages so gained were greatly diminished by the very severe spring and summer season of 1958. However, the earlier start did appear to create more permanent differences than in the 1956 born age group.

It can be seen that season is undoubtedly the most important single factor in determining growth and development, having a greater influence than any wintering treatment. The first six months of life are probably of greater importance than the second six months and more attention to this period of growth could, by its effect on what would otherwise become the light animals at six months, greatly reduce the necessity for expensive wintering, with an improvement in the general standard of the hoggs and in their subsequent production.

SUMMARY

1. During the winter of 1956-57, 40 South Country Cheviot and 38 North Country Cheviot ewe hoggs were fed in three groups in each breed on H.P., M.P. and L.P. diets from 27 - 49 weeks. During the winter of 1957-58, 25 S.C.C. and 28 N.C.C. ewe hoggs were fed in two groups in each breed on H.P. and M.P. diets from 22 - 49 weeks, with 12 S.C.C. and 14 N.C.C. ewe hoggs remaining on the hill as controls. During the winter of 1958-59, 14 S.C.C. and 15 N.C.C. ewe hoggs were wintered in grass fields and away on a low ground grass farm from 25 - 49 weeks, while 13 S.C.C. and 15 N.C.C. ewe hoggs remained on the hill as controls.

2. In the 1956 born age group, hoggs fed on a L.P. diet lost 7 lb. (10%) over the winter, M.P. fed hoggs were maintained in weight, making them 7 - 9 lb. (11 - 13%) heavier than the L.P. hoggs and H.P. fed hoggs gained 13 - 15 lb., making them 21 - 22 lb. (34 - 35%) heavier than the L.P. hoggs. In the 1957 born age group, Hill hoggs lost 6 - 10 lb. (10 - 15%) over the winter, M.P. fed hoggs gained 2 - 4 lb., making them 10 - 14 lb. (18 - 24%) heavier than the Hill hoggs and H.P. fed hoggs gained 20 - 23 lb., making them 26 - 34 lb. (47 - 57%) heavier than the Hill hoggs. In the 1958 born age group, Hill hoggs gained 3 - 5 lb. over the winter and Away hoggs gained 9 - 10 lb., making them 6 - 7 lb. (9 - 12%) heavier than the former.

3. The live weight changes of these different groups on the hill are examined over the summer after treatment from 12 - 18 months and from 18 months onwards. The differences between H.P. and L.P./Hill groups were halved by 18 months but were still significant at 2 years. The M.P. groups gave different results in the two breeds, possible explanations for this are discussed. The differences between moderate away wintering and above average hill wintering disappeared by 2 years. After this time differential productivity influenced

live weight changes more than treatment.

4. Changes in size and conformation as affected by treatment are examined over the winter, from 12 - 18 months and from 18 months onwards, by seven live measurements, heart girth, body length, pelvis length, pelvis width, fore-cannon length, leg length and tibia length. Treatment effects were greater on the body measurements than on the leg measurements and the earlier start to treatment in 1957 created greater differences than the later start in 1956. Significance tended to disappear from the differences in leg measurements by 18 months but remained in certain of the body measurements to 27 and 39 months, particularly the pelvis measurements. Implications of changes in size on future survival and production are discussed.

5. Sample animals from each breed prior to treatment and from each treatment group at 12 and 18 months were slaughtered and partially dissected. The relative changes with age as affected by treatment are examined in various body parts, organs and their accompanying tissues of the total carcass and in the joints and individual tissues of the hindquarters. Treatment effects were smaller but more permanent on bone growth, particularly in thickness, than on muscle and fat. The latter tissue showed the greatest response to treatment and the resultant greater "condition" at 18 months of animals wintered on improved diets is discussed with regard to its possible advantage during the first productive year. Dissected bone measurements give complementary information to the live measurements on skeletal size. Greater width growth of the pelvic bone in animals wintered on improved diets is discussed with regard to a reduction in difficult births, while greater development of the reproductive organs is similarly discussed with regard to a reduction in barrenness and an increase in twin births in the first productive year.

6. The relative growth and development of heavy and light hoggs prior to

treatment in each treatment group is examined from the changes occurring in live weight and the live measurements over the treatment period, from 12 - 18 months and from 18 months onwards. Treatment effects were greater on the light than on the heavy hoggs but failed to permanently overcome the differences between the weight classes, the latter showing greater potential during the later stages of growth and development than the former. Treatment differences persisted in the light hoggs, significantly so in weight and size to 2 years and still sizable at 3 years but disappeared in the heavy hoggs between 18 months and 2 years. The implications of growth and development at 6 months are discussed with regard to future performance and suggestions are made as to the importance of the first 6 months of life which may warrant greater attention than the winter period.

7. Seasonal effects during the first 6 months of life and between 12 and 18 months are discussed in relation to their interaction with wintering treatment and are shown to have a considerable influence on growth and development and on subsequent performance.

8. The earlier maturity resulting from improved wintering treatments is demonstrated by earlier eruption of the permanent incisor teeth, particularly the first pair. Possible implications of this on long term productive life are discussed.

9. Mortality rate was higher in those groups which received a higher standard of wintering and were the heaviest and largest in later life. Possible explanations for this are discussed.

10. Wool production in the first year was very greatly affected by treatment but in subsequent years it was more closely related to the condition of the animals at mating time and to their lamb production in the previous season than it was to treatment.

11. Barrenness was generally reduced and twin births increased in the first productive year from those animals which received improved winter diets. Lamb survival was closely related to the condition of the gimmers at 18 months and very greatly affected by season during the first productive year. The percentage of lambs weaned in the first year was therefore greater from the improved wintering treatments but seasonal effects could either exaggerate or diminish these treatment differences. Subsequent lamb crops were less affected by season than gimmer lamb crops and continued to show reduced but more positive treatment differences in the second and third productive years, with L.P./Hill wintered animals weaning on average 20% fewer lambs than from the other treatments, which were very similar. Treatment effects were generally greater on the number of lambs produced, by reducing barrenness, increasing twin births and reducing twin lamb losses, than on weights of lambs or milking ability of the ewes. A lowering of the overall standard of the lambs is suggested from improved wintering treatments, through greater production and increased chance of survival, as shown by the smaller percentage of ewe lambs retained for replacement from these groups compared with the L.P./Hill groups.

12. General implications of improved wintering treatments on growth and development and the effect of the greater size and earlier maturity so achieved on survival and production throughout the hill productive life are discussed and suggestions are made as to the most economic and efficient rearing systems.

ADDENDUM

From the results embodied in this thesis it has not been possible to comment on the long term effects of treatment on productive performance. However, during the writing of the thesis a further one and a half productive seasons were recorded, giving almost a full hill life cycle for the oldest age group. For the sake of completeness and to avoid any misleading assumptions from performance during the earlier years, the results obtained during this time were as follows.

The percentages of lambs weaned in the 1961 lamb crop, the fourth born to the 1956 age group and the third to the 1957 age group, were:-

	Born 1956			Born 1957		
	H.P.	M.P.	L.P.	H.P.	M.P.	Hill
S.C.C.	75	100	73	80	88	122
N.C.C.	110	113	140	91	117	127

With the exception of the S.C.C. animals born 1956, the picture is one of the smallest percentage of lambs weaned from the H.P. reared groups and the largest from the L.P./Hill reared groups. Two non-producers in the 1956 born S.C.C. L.P. group compared with none in the H.P. group disguised a similar trend in this age group. At marking time in the 1962 lamb crop a similar picture was developing in both age groups but to an apparently lesser degree. Very little difference existed in the 1958 born age group in either year.

These results suggest that while H.P. rearing creates a higher level of more efficient production in early life relative to L.P. or Hill rearing, the reverse is the case in later life. Being under less strain through only limited production in their early years, the L.P./Hill reared animals were apparently in better condition to realise their full potential for production in a mild winter and early spring, as in 1961, than the H.P. reared animals, whose greater initial production with its greater strain and resultant poorer condition, has resulted in failure to respond so strikingly.

It is therefore suggested that earlier maturity and improved production in early life, resulting from higher standards of rearing, are not to the animal's advantage in terms of long term productivity under the stresses of a hill environment and that for best results over the full hill life a slower rate of growth and later maturity are preferable, with M.P. or maintenance rearing supplying the optimum.

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APPENDIX I

Details of origin and history of ewe hoggs allocated to treatment groups

	S.C.C.			N.C.C.		
1956 Total Nos.	H.P. 13	M.P. 13	L.P. 14	H.P. 13	M.P. 13	L.P. 12
Heft: Near End	7	6	7	6	5	6
Far End	5	7	6	7	8	6
Unknown	1	–	1	–	–	–
Age of dam: 6 years	2	3	2	3	2	2
5 years	4	3	4	1	2	1
4 years	3	3	3	3	2	2
3 years	1	2	2	3	4	4
2 years	2	2	2	3	3	3
Unknown	1	–	1	–	–	–
Singles	11	10	11	9	9	9
Twins	1	–	–	2	3	2
Twins reared as singles	1	3	3	2	1	1
Mean birth date	24.3/4	21.6/4	27.7/4	25.2/4	27.2/4	24.3/4
1957 Total Nos.	H.P. 13	M.P. 12	Hill 12	H.P. 14	M.P. 14	Hill 14
Heft: Near End	6	5	6	6	7	6
Far End	7	6	6	8	7	8
Unknown	–	1	–	–	–	–
Age of dam: 6 years	2	2	2	1	2	2
5 years	3	3	2	2	3	4
4 years	2	1	2	4	4	3
3 years	4	4	4	3	3	3
2 years	2	1	2	2	2	2
Unknown	–	1	–	–	–	–
Singles	11	9	9	8	7	8
Twins	1	1	1	3	4	3
Twins reared as singles	1	2	2	3	3	3
Mean birth date	24.25/4	25.1/4	26.9/4	24.7/4	24.1/4	23.6/4

1958 Total Nos.	Away 14	Hill 13	Away 15	Hill 15
Heft: Near End	5	5	8	7
Far End	7	6	7	8
Unknown	2	2	–	–
Age of dam: 6 years	2	2	2	1
5 years	2	2	3	5
4 years	5	5	5	6
3 years	3	2	4	3
2 years	–	–	1	–
Unknown	2	2	–	–
Singles	14	12	9	8
Twins	–	–	1	2
Twins reared as singles	–	1	5	5
Mean birth date	27.0/4	26.2/4	25.3/4	26.6/4

APPENDIX II

Table of daily rations fed to achieve the intended differences in live weight of the 1956 experimental ewe hoggs

		High Plane	Mid Plane	Low Plane
29/10/56	S.C.C.) N.C.C.)	*Hay ad lib. as an introductory diet		
7/11/56	S.C.C.) N.C.C.)	Hay ad lib. plus 2 ozs.+ concentrates		
≠14/11/56	S.C.C.) N.C.C.)	(Hay ad lib. (4 ozs. concs.	Hay ad lib. 2 ozs. concs.	Hay ad lib.
5/12/56	S.C.C.) N.C.C.)	(Hay ad lib. (6 ozs. concs.	2 lbs. hay 2 ozs. concs.	2 lbs. hay
29/12/56	S.C.C.) N.C.C.)	(Hay ad lib. (8 ozs. concs.	2 lbs. hay 2 ozs. concs.	2 lbs. hay
21/1/57	S.C.C.	(Hay ad lib. (8 ozs. concs.	$1\frac{3}{4}$ lbs. hay 2 ozs. concs.	1 lb. hay 1 lb. oat straw
	N.C.C.	(Hay ad lib. (9 ozs. concs.	2 lbs. hay 2 ozs. concs.	1 lb. hay 1 lb. oat straw
9/2/57	S.C.C.	(Hay ad lib. (10 ozs. concs.	$1\frac{3}{4}$ lbs. hay 2 ozs. concs.	$\frac{3}{4}$ lb. hay $\frac{3}{4}$ lb. oat straw
	N.C.C.	(Hay ad lib. (12 ozs. concs.	2 lbs. hay 2 ozs. concs.	1 lb. hay 1 lb. oat straw
13/2/57		**Nature of the concentrate ration altered		
23/2/57	S.C.C.	($2\frac{1}{2}$ lbs. hay ((1 lb.11% C.P.) (14 ozs. concs.	2 lbs. hay 3 ozs. concs.	2 lbs. hay
	N.C.C.	($2\frac{1}{2}$ lbs. hay ((1 lb.11% C.P.) (16 ozs. concs.	2 lbs. hay 4 oz. concs.	2 lbs. hay
28/3/57	S.C.C.) N.C.C.)	Hay ad lib. as a night supplement to daytime grazing		
2/4/57		End of winter feeding period		

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* Unless otherwise stated, the hay sample was one containing $5\frac{1}{2}$% C.P.

+ Bruised oats, linseed cake and fish meal in the ratio 7 : 2 : 1, plus 5% minerals and vitamins.

≠ Minerals plus vitamins offered in boxes and not mixed with concentrates.

** Bruised oats, flaked maize, linseed cake and fish meal in the ratio 4 : 3 : 2 : 1.

APPENDIX III

Table of daily rations fed to achieve the intended differences in live weight of the 1957 experimental ewe hoggs

		High Plane	Mid Plane
27/9/57	S.C.C.) N.C.C.)	*Hay ad lib. plus 2 ozs.+ concs. as an introductory diet.	
≠14/10/57	S.C.C.	(2 lbs. hay (4 ozs. concs.	2 lbs. hay 2 ozs. concs.
	N.C.C.	(2 lbs. hay (5 ozs. concs.	2 lbs. hay $2\frac{1}{2}$ ozs. concs.
21/10/57	S.C.C.) N.C.C.)	Hay ration reduced to $1\frac{1}{2}$ lbs.	
23/11/57	S.C.C.	($1\frac{1}{2}$ lbs. hay (8 ozs. concs.	$1\frac{1}{2}$ lbs. hay 2 ozs. concs.
	N.C.C.	($1\frac{1}{2}$ lbs. hay (9 ozs. concs.	$1\frac{1}{2}$ lbs. hay $2\frac{1}{2}$ ozs. concs.
4/12/57	S.C.C.	(2 lbs. hay (16 ozs. concs.	2 lbs. hay 8 ozs. concs.
	N.C.C.	(2 lbs. hay (16 ozs. concs.	2 lbs. hay 8 ozs. concs.
10/12/57	S.C.C.) N.C.C.)	Hay ration reduced to $1\frac{3}{4}$ lbs. One part by weight of bran added to concs.	
14/1/58	S.C.C.	(1 lb. hay (22 ozs. concs.	$1\frac{3}{4}$ lbs. hay 8 ozs. concs.
	N.C.C.	(1 lb. hay (24 ozs. concs.	$1\frac{3}{4}$ lbs. hay 8 ozs. concs.
27/1/58	S.C.C.	($1\frac{1}{2}$ lbs. hay (22 ozs. concs.	$2\frac{1}{2}$ lbs. hay 2 ozs. concs.
	N.C.C.	($1\frac{1}{2}$ lbs. hay (24 ozs. concs.	$2\frac{1}{2}$ lbs. hay 2 ozs. concs.
30/1/58	S.C.C.) N.C.C.)	Hay ration reduced by $\frac{1}{2}$ lb.	
24/2/58	N.C.C.	-	Concs. increased to 4 ozs.
17/3/58	N.C.C.	-	Concs. reduced to 3 ozs.
3/4/58	S.C.C.) N.C.C.)	2 lbs. hay plus 8 ozs. concs. as a night supplement to daytime grazing.	
7/4/58		End of winter feeding period	

* The hay sample used throughout contained 7% C.P.
+ Same mixture as used in latter stages of 1956 winter feeding, see APPENDIX II
≠ Minerals plus vitamins offered at periodic intervals throughout the feeding period.

APPENDIX IV

Details of live weight and live measurements of animals born 1956 and slaughtered for dissection, being the criteria used for selection.*

	Treatment	No.	Live weight	Girth	S.C.C. Body length	Pelvis length	Pelvis width	Cannon length	Leg length	Tibia length
27 weeks	Pre-treatment	Breed mean	67.0	673	578	185	146	119	317	173
		C 530	65	660	585	182	146	118	310	172
		C 535	67	680	575	191	147	117	305	173
49 weeks	H.P.	Group mean	80.2	749	620	196	161	124	339	185
		C 520	83	725	620	200	163	125	320	190
	M.P.	Group mean	65.6	687	593	186	148	119	332	180
		C 510	69	665	605	187	152	121	345	185
	L.P.	Group mean	59.3	650	579	181	144	119	320	174
		C 502	61	655	605	184	145	120	325	171
80 weeks	H.P.	Group mean	102.8	835	673	216	180	130	372	194
		C 532	105	845	660	219	182	132	380	192
	M.P.	Group mean	91.5	796	647	208	173	126	362	189
		C 537	100	815	655	208	170	126	365	181
	L.P.	Group mean	92.6	797	648	206	173	127	364	189
		C 507	89	790	635	199	174	130	360	189

* Live weights in lb., live measurements in mms.

APPENDIX IV (contd.)

Details of live weight and live measurements of animals born 1956 and slaughtered for dissection, being the criteria used for selection.*

	Treatment	No.	Live weight	Girth	N.C.C. Body length	Pelvis length	Pelvis width	Cannon length	Leg length	Tibia length
27 weeks	Pre-treatment	Breed mean	74.0	714	601	191	153	125	344	183
		A 377	72	705	595	194	158	125	340	182
		A 381	73	685	610	191	148	126	345	183
49 weeks	H.P.	Group mean	88.7	785	640	203	164	131	355	195
		A 384	86	735	630	208	161	132	365	192
	M.P.	Group mean	75.0	702	620	198	158	127	346	191
		A 370	79	645	660	201	159	126	340	195
	L.P.	Group mean	66.3	675	600	191	151	128	350	193
		A 362	64	690	610	196	143	129	345	191
80 weeks	H.P.	Group mean	110.8	859	700	224	187	134	390	208
		A 364	114	885	700	220	194	137	385	214
	M.P.	Group mean	110.0	840	682	220	187	135	382	204
		A 408	110	835	675	219	192	131	365	207
	L.P.	Group mean	99.7	815	685	216	181	134	387	203
		A 365	92	820	680	215	178	138	400	203

* Live weights in lb., live measurements in mms.

APPENDIX V

Details of live weight and live measurements of animals born 1957 and slaughtered for dissection, being the criteria used for selection.*

S.C.C.

	Treatment	No.	Live weight	Girth	Body length	Pelvis length	Pelvis width	Cannon length	Leg length	Tibia length
22 weeks	Pre-treatment	Breed mean	63.0	672	580	183	140	113	320	167
		C 124	63	670	580	184	143	110	310	166
		C 23	61	675	555	181	135	112	315	167
49 weeks	H.P.	Group mean	82.3	748	624	202	157	120	341	179
		C 710	83	730	640	202	154	121	340	179
	M.P.	Group mean	66.3	672	591	193	146	120	338	178
		C 720	65	660	585	194	147	121	330	178
	Hill	Group mean	56.1	633	575	184	141	117	337	173
		C 708	58	650	570	186	142	115	335	177
79 weeks	H.P.	Group mean	101.3	793	679	220	183	122	353	184
		C 717	101	815	650	220	182	122	355	186
	M.P.	Group mean	97.8	771	675	214	176	123	354	187
		C 703	93	775	650	217	180	122	355	182
	Hill	Group mean	89.2	751	653	207	172	124	353	181
		C 719	87	760	655	213	177	129	365	173

* Live weights in lb., live measurements in mms.

APPENDIX V (contd.)

Details of live weight and live measurements of animals born 1957 and slaughtered for dissection, being the criteria used for selection.*

N.C.C.

	Treatment	No.	Live weight	Girth	Body length	Pelvis length	Pelvis width	Cannon length	Leg length	Tibia length
22 weeks	Pre-treatment	Breed mean	69.4	704	601	190	143	124	350	181
		N 4	74	720	605	192	147	126	360	182
		N 68	61	670	590	187	142	123	355	179
49 weeks	H.P.	Group mean	92.6	782	652	211	160	134	379	199
		A 727	93	770	640	220	157	134	375	198
	M.P.	Group mean	73.3	714	610	200	149	129	374	194
		A 713	68	680	620	193	144	130	370	190
	Hill	Group mean	59.1	663	585	188	139	127	363	186
		A 708	57	640	585	183	136	126	365	187
79 weeks	H.P.	Group mean	109.3	830	703	228	185	137	395	207
		A 722	107	815	715	226	180	135	395	206
	M.P.	Group mean	104.0	821	696	225	182	137	393	205
		A 719	102	825	680	224	175	133	385	198
	Hill	Group mean	93.5	793	665	215	169	135	383	199
		A 723	92	775	655	217	174	130	375	196

* Live weights in lb., live measurements in mms.

APPENDIX VI

Details of age and weight of animals born 1956 and slaughtered for dissection. (Weights in lb.)

Treatment	No.	Age in weeks	Date of slaughter	Live wt. unfasted	Live wt. fasted	Wt. of carcass + head, warm	Wt. of head	Wt. of carcass − head, cold	Loss in cooling
					S.C.C.				
Pre-	(C 530	29	5.11.56	57	54	31.0	2.6	28.0	0.4
treatment	(C 535	29	7.11.56	56	54	30.5	2.7	27.5	0.3
H.P.	C 520	51	8.4.57	83	76	42.0	3.9	38.0	0.1
M.P.	C 510	51	8.4.57	69	65	32.0	3.3	28.5	0.2
L.P.	C 502	50	4.4.57	61	57	26.0	2.9	22.5	0.6
H.P.	C 532	80	14.11.57	105	94	53.0	4.6	47.5	0.9
M.P.	C 537	82	14.11.57	100	89	47.0	4.0	42.5	0.5
L.P.	C 507	81	12.11.57	89	85	42.0	3.7	37.5	0.8
					N.C.C.				
Pre-	(A 377	29	7.11.56	61	58	33.5	2.7	30.5	0.3
treatment	(A 381	28	5.11.56	67	62	34.0	2.8	31.0	0.2
H.P.	A 384	49	4.4.57	86	82	43.5	4.0	39.0	0.5
M.P.	A 370	49	10.4.57	79	75	36.0	3.7	33.0	-0.7
L.P.	A 362	50	10.4.57	64	63	29.0	3.4	26.0	-0.4
H.P.	A 364	81	18.11.57	114	107	60.0	4.6	55.0	0.4
M.P.	A 408	79	18.11.57	110	100	53.5	4.7	48.5	0.3
L.P.	A 365	81	12.11.57	92	90	48.0	4.3	43.0	0.7

APPENDIX VII

Details of age and weight of animals born 1957 and slaughtered for dissection. (Weights in lb.)

Treatment	No.	Age in weeks	Date of slaughter	Live wt. unfasted	Live wt. fasted	Wt. of carcass + head, warm	Wt. of head	Wt. of carcass - head, cold	Loss in cooling
					S.C.C.				
Pre-	(C 124	-	2.10.57	63	58	32.5	2.9	29.0	0.6
treatment	(C 23	23	2.10.57	61	56	28.5	2.5	25.5	0.5
H.P.	C 710	50	9.4.58	83	83	42.5	3.7	38.5	0.3
M.P.	C 720	49	7.4.58	65	62	30.5	3.4	27.0	0.1
Hill	C 708	49	3.4.58	58	51	26.5	3.1	23.0	0.4
H.P.	C 717	79	3.11.58	101	91	50.0	4.2	45.5	0.3
M.P.	C 703	81	5.11.58	93	79	45.0	3.7	41.0	0.3
Hill	C 719	79	30.10.58	87	80	42.0	3.8	38.0	0.2
					N.C.C.				
Pre-	(N 4	24	30.9.57	73	66	36.5	3.0	33.0	0.5
treatment	(N 68	23	30.9.57	64	58	31.0	3.0	27.0	1.0
H.P.	A 727	50	9.4.58	93	88	49.5	3.9	45.0	0.6
M.P.	A 713	50	7.4.58	68	68	32.0	3.6	28.0	0.4
Hill	A 708	49	3.4.58	57	50	26.5	3.2	23.0	0.3
H.P.	A 722	80	3.11.58	107	101	57.0	4.5	51.0	1.5
M.P.	A 719	80	5.11.58	102	97	52.0	4.1	47.0	0.9
Hill	A 723	80	30.10.58	92	87	46.5	4.0	42.0	0.5

APPENDIX VIII

Actual weights of muscle, fat, bone and tendon in the hindquarter joints of animals born 1956 (gms.)

		Total	Muscle	Subcutaneous fat	Intermuscular fat	Bone	Tendon etc.	Loss in dissection
29 weeks Pre-treatment S.C.C. 530								
	Loin	1385	898	166	131	122	20	48
	Pelvis	1354	825	152	137	137	65*	38
Leg R.	Thigh)	1596	(950)	110	(79	83)	12	18
	Leg)		(234)		(18	92)		
Leg L.	Thigh)	1610	(989)	94	(73	88)	19	16
	Leg)		(227)		(22	82)		
Total joints		5945	4123	522	460	604	116	120
Pre-treatment S.C.C. 535								
	Loin	1295	831	170	142	103	27	22
	Pelvis	1386	743	201	167	146	66*	63
Leg R.	Thigh)	1443	(807)	140	(58	79)	16	37
	Leg)		(207)		(14	85)		
Leg L.	Thigh)	1427	(821)	134	(60	77)	19	23
	Leg)		(194)		(16	83)		
Total joints		5551	3603	645	457	573	128	145
50 weeks H.P. S.C.C. 520								
	Loin	1687	1207	145	111	160	35	29
	Pelvis	1773	1072	164	174	218	113*	32
Leg R.	Thigh)	2172	(1271)	180	(78	117)	54	23
	Leg)		(300)		(25	124)		
Leg L.	Thigh)	2115	(1237)	181	(59	116)	20	35
	Leg)		(321)		(27	119)		
Total joints		7747	5408	670	474	854	222	119
M.P. S.C.C. 510								
	Loin	1234	890	45	110	132	33	24
	Pelvis	1316	844	76	129	179	61*	27
Leg R.	Thigh)	1650	(911)	115	(81	115)	24	29
	Leg)		(233)		(30	112)		
Leg L.	Thigh)	1612	(911)	97	(74	113)	25	19
	Leg)		(231)		(29	113)		
Total joints		5812	4020	333	453	764	143	99

* Includes weight of undissected tail.

APPENDIX VIII (contd.)

L.P. S.C.C. 502		Total	Muscle	Subcutaneous fat	Intermuscular fat	Bone	Tendon etc.	Loss in dissection
	Loin	910	688	15	28	122	39	18
	Pelvis	1170	768	65	100	169	41*	27
Leg R.	Thigh)	1313	(775)	53	(42	98)	20	17
	Leg)		(188)		(23	97)		
Leg L.	Thigh)	1303	(759)	53	(43	100)	27	27
	Leg)		(181)		(21	92)		
Total joints		4696	3359	186	257	678	127	89
81 weeks H.P. S.C.C. 532								
	Loin	1968	1264	303	191	160	26	24
	Pelvis	2216	1274	455	135	245	90*	17
Leg R.	Thigh)	2465	(1407)	247	(112	136)	28	24
	Leg)		(316)		(54	141)		
Leg L.	Thigh)	2408	(1398)	250	(110	132)	40	11
	Leg)		(289)		(40	138)		
Total joints		9057	5948	1255	642	952	184	76
M.P. S.C.C. 537								
	Loin	1938	1300	239	209	157	9	24
	Pelvis	2170	1212	344	270	227	93*	24
Leg R.	Thigh)	2176	(1302)	192	(36	121)	23	30
	Leg)		(307)		(38	127)		
Leg L.	Thigh)	2202	(1262)	217	(115	119)	19	19
	Leg)		(301)		(27	123)		
Total joints		8486	5684	992	695	874	144	97
L.P. S.C.C. 507								
	Loin	1743	1223	161	178	139	19	23
	Pelvis	1929	1174	220	219	204	91*	21
Leg R.	Thigh)	2088	(1247)	146	(80	114)	15	25
	Leg)		(304)		(29	128)		
Leg L.	Thigh)	2029	(1209)	163	(80	111)	15	13
	Leg)		(294)		(27	117)		
Total joints		7789	5451	690	613	813	140	82

* Includes weight of undissected tail.

APPENDIX VIII (contd.)

29 weeks Pre-treatment N.C.C. 377		Total	Muscle	Subcutaneous fat	Intermuscular fat	Bone	Tendon etc.	Loss in dissection
	Loin	1491	981	160	168	124	33	25
	Pelvis	1502	837	230	200	162	59*	14
Leg R.	Thigh)	1683	(985)	151	(57	89)	22	26
	Leg)		(246)		(10	97)		
Leg L.	Thigh)	1662	(991)	137	(41	90)	22	18
	Leg)		(249)		(16	98)		
Total joints		6338	4289	678	492	660	136	83
Pre-treatment N.C.C. 381								
	Loin	1599	1026	197	196	135	17	28
	Pelvis	1427	858	173	164	152	64*	16
Leg R.	Thigh)	1692	(1009)	132	(44	96)	24	17
	Leg)		(240)		(27	103)		
Leg L.	Thigh)	1710	(989)	146	(70	96)	20	16
	Leg)		(250)		(20	103)		
Total joints		6428	4372	648	521	685	125	77
50 weeks H.P. N.C.C. 384								
	Loin	1693	1175	124	138	159	51	46
	Pelvis	2023	1259	185	231	217	78*	53
Leg R.	Thigh)	2243	(1351)	165	(75	125)	67	21
	Leg)		(289)		(23	127)		
Leg L.	Thigh)	2173	(1290)	138	(93	123)	33	36
	Leg)		(310)		(24	126)		
Total joints		8132	5674	612	584	877	229	156
M.P. N.C.C. 370								
	Loin	1532	1096	91	80	138	81	46
	Pelvis	1541	985	92	157	192	87*	28
Leg R.	Thigh)	1896	(1096)	127	(58	123)	50	35
	Leg)		(249)		(36	122)		
Leg L.	Thigh)	1918	(1100)	145	(75	124)	23	28
	Leg)		(265)		(40	118)		
Total joints		6887	4791	455	446	817	241	137

* Includes weight of undissected tail.

APPENDIX VIII (contd.)

		Total	Muscle	Subcutaneous fat	Intermuscular fat	Bone	Tendon etc.	Loss in dissection
L.P. N.C.C. 362								
	Loin	1106	781	44	99	122	30	30
	Pelvis	1187	777	44	130	156	56*	24
Leg R.	Thigh)	1430	(806)	64	(59	104)	38	10
	Leg)		(220)		(22	107)		
Leg L.	Thigh)	1470	(833)	68	(67	103)	24	15
	Leg)		(224)		(29	107)		
Total joints		5193	3641	220	406	699	148	79
81 weeks H.P. N.C.C. 364								
	Loin	2460	1465	387	367	184	30	27
	Pelvis	2886	1604	485	382	278	109*	28
Leg R.	Thigh)	2637	(1549)	232	(114	145)	17	29
	Leg)		(357)		(49	145)		
Leg L.	Thigh)	2667	(1565)	248	(112	147)	27	29
	Leg)		(353)		(42	144)		
Total joints		10650	6893	1352	1066	1043	183	113
M.P. N.C.C. 408								
	Loin	2124	1311	285	283	175	45	25
	Pelvis	2442	1400	398	268	252	91*	33
Leg R.	Thigh)	2396	(1424)	197	(104	132)	29	15
	Leg)		(330)		(24	141)		
Leg L.	Thigh)	2322	(1382)	170	(97	134)	41	11
	Leg)		(329)		(15	143)		
Total joints		9284	6176	1050	791	977	206	84
L.P. N.C.C. 365								
	Loin	2066	1155	465	251	139	25	31
	Pelvis	2130	1122	519	177	205	82*	25
Leg R.	Thigh)	2137	(1195)	213	(108	126)	20	17
	Leg)		(299)		(30	129)		
Leg L.	Thigh)	2147	(1192)	271	(131	118)	27	24
	Leg)		(237)		(26	121)		
Total joints		8480	5200	1468	723	838	154	97

* Includes weight of undissected tail.

APPENDIX IX

Actual weights of muscle, fat, bone and tendon in the hindquarter joints of animals born 1957 (gms.)

24 weeks Pre-treatment S.C.C. 124		Total	Muscle	Subcutaneous fat	Intermuscular fat	Bone	Tendon etc.	Loss in dissection
	Loin	1421	889	151	189	122	27	43
	Pelvis	1343	705	214	181	143	75*	25
Leg R.	Thigh)	1542	(866)	139	(83	92)	10	18
	Leg)		(214)		(24	96)		
Leg L.	Thigh)	1468	(815)	138	(79	88)	11	23
	Leg)		(200)		(25	89)		
Total joints		5774	3689	642	581	630	123	109
Pre-treatment S.C.C. 23								
	Loin	1130	743	96	152	97	22	20
	Pelvis	1216	681	180	148	129	62*	16
Leg R.	Thigh)	1339	(789)	80	(62	79)	10	25
	Leg)		(188)		(20	86)		
Leg L.	Thigh)	1390	(828)	104	(50	80)	9	13
	Leg)		(200)		(22	84)		
Total joints		5075	3429	460	454	555	103	74
50 weeks H.P. S.C.C. 710								
	Loin	1930	1211	215	300	161	17	26
	Pelvis	1827	1009	282	246	179	100*	11
Leg R.	Thigh)	1869	(1075)	155	(99	100)	25	8
	Leg)		(260)		(40	107)		
Leg L.	Thigh)	1862	(1080)	155	(95	100)	25	9
	Leg)		(246)		(45	107)		
Total joints		7488	4881	807	825	754	167	54
M.P. S.C.C. 720								
	Loin	1247	899	74	130	117	7	20
	Pelvis	1290	796	63	196	171	46*	18
Leg R.	Thigh)	1512	(895)	71	(65	101)	26	15
	Leg)		(223)		(15	101)		
Leg L.	Thigh)	1461	(847)	63	(75	100)	20	1
	Leg)		(225)		(30	100)		
Total joints		5510	3885	271	511	690	99	54

* Includes weight of undissected tail.

APPENDIX IX (contd.)

Hill S.C.C. 708		Total	Muscle	Subcutaneous fat	Intermuscular fat	Bone	Tendon etc.	Loss in dissection
	Loin	1070	805	22	82	117	24	20
	Pelvis	1087	715	28	128	162	35*	19
Leg R.	Thigh)	1358	(799)	42	(26	99)	23	11
	Leg)		(215)		(38	105)		
Leg L.	Thigh)	1287	(755)	39	(54	100)	21	5
	Leg)		(197)		(17	99)		
Total joints		4802	3486	131	345	682	103	55
80 weeks H.P. S.C.C. 717								
	Loin	2242	1393	395	271	152	9	22
	Pelvis	2345	1306	425	261	217	118*	18
Leg R.	Thigh)	2185	(1287)	170	(92	126)	20	12
	Leg)		(315)		(35	128)		
Leg L.	Thigh)	2250	(1317)	205	(81	123)	45	11
	Leg)		(309)		(32	127)		
Total joints		9022	5927	1195	772	873	192	63
M.P. S.C.C. 703								
	Loin	1951	1252	320	207	154	11	7
	Pelvis	2165	1178	310	331	242	87*	17
Leg R.	Thigh)	1969	(1157)	156	(79	117)	10	13
	Leg)		(287)		(30	120)		
Leg L.	Thigh)	1932	(1125)	156	(89	117)	17	12
	Leg)		(278)		(21	117)		
Total joints		8017	5277	942	757	867	125	49
Hill S.C.C. 719								
	Loin	1842	1194	274	158	146	42	28
	Pelvis	1954	1131	277	247	208	73*	18
Leg R.	Thigh)	1845	(1082)	123	(80	111)	15	7
	Leg)		(291)		(21	115)		
Leg L.	Thigh)	1767	(1027)	125	(95	108)	29	7
	Leg)		(246)		(21	109)		
Total joints		7408	4971	799	622	797	159	60

* Includes weight of undissected tail.

APPENDIX IX (contd.)

		Total	Muscle	Subcutaneous fat	Intermuscular fat	Bone	Tendon etc.	Loss in dissection
24 weeks Pre-treatment N.C.C. 4								
	Loin	1506	975	176	184	133	6	32
	Pelvis	1602	967	200	180	164	78*	13
Leg R.	Thigh) Leg)	1819	(1000) (241)	174	(109 (42	107) 113)	11	22
Leg L.	Thigh) Leg)	1748	(953) (249)	155	(98 (44	107) 114)	13	15
Total joints		6675	4385	705	657	738	108	82
Pre-treatment N.C.C. 68								
	Loin	1245	928	91	74	124	6	22
	Pelvis	1341	891	120	80	170	62*	18
Leg R.	Thigh) Leg)	1528	(911) (230)	88	(51 (11	96) 101)	19	21
Leg L.	Thigh) Leg)	1566	(956) (234)	85	(40 (20	98) 106)	10	17
Total joints		5680	4150	384	276	695	97	78
50 weeks H.P. N.C.C. 727								
	Loin	2195	1298	420	232	166	55	24
	Pelvis	2231	1168	430	303	221	83*	26
Leg R.	Thigh) Leg)	2242	(1240) (325)	233	(113 (42	120) 127)	31	11
Leg L.	Thigh) Leg)	2250	(1249) (324)	246	(105 (41	120) 125)	21	19
Total joints		8918	5604	1329	836	879	190	80
M.P. N.C.C. 713								
	Loin	1240	907	47	133	125	8	20
	Pelvis	1407	931	93	146	161	50*	26
Leg R.	Thigh) Leg)	1614	(890) (270)	74	(64 (42	112) 117)	22	23
Leg L.	Thigh) Leg)	1624	(929) (265)	68	(62 (40	112) 114)	23	11
Total joints		5885	4192	282	487	741	103	80

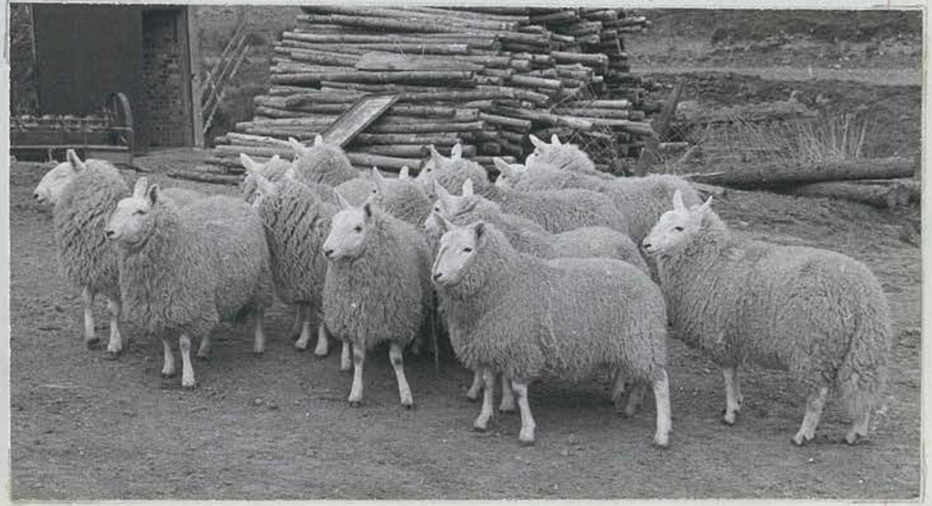
* Includes weight of undissected tail.

APPENDIX IX (contd.)

Hill N.C.C. 708		Total	Muscle	Subcutaneous fat	Intermuscular fat	Bone	Tendon etc.	Loss in dissection
	Loin	1046	776	12	103	115	18	22
	Pelvis	1115	777	17	113	135	53*	20
Leg R.	Thigh)	1372	(807)	50	(52	92)	35	15
	Leg)		(202)		(18	101)		
Leg L.	Thigh)	1405	(845)	45	(44	96)	28	13
	Leg)		(214)		(18	102)		
Total joints		4938	3621	124	348	641	134	70
80 weeks H.P. N.C.C. 722								
	Loin	2389	1555	368	248	182	10	26
	Pelvis	2725	1632	428	246	272	125*	22
Leg R.	Thigh)	2529	(1499)	190	(95	147)	25	8
	Leg)		(387)		(25	153)		
Leg L.	Thigh)	2521	(1482)	205	(120	144)	14	10
	Leg)		(365)		(36	145)		
Total joints		10164	6920	1191	770	1043	174	66
M.P. N.C.C. 719								
	Loin	2378	1443	416	305	155	37	22
	Pelvis	2550	1420	477	290	229	111*	23
Leg R.	Thigh)	2323	(1353)	196	(117	131)	25	3
	Leg)		(328)		(36	134)		
Leg L.	Thigh)	2255	(1292)	198	(112	131)	19	5
	Leg)		(324)		(40	134)		
Total joints		9506	6160	1287	900	914	192	53
Hill N.C.C. 723								
	Loin	2146	1306	405	175	180	41	39
	Pelvis	2106	1266	330	218	203	77*	12
Leg R.	Thigh)	2092	(1206)	175	(92	118)	20	6
	Leg)		(295)		(49	131)		
Leg L.	Thigh)	2085	(1192)	173	(80	121)	20	14
	Leg)		(297)		(57	131)		
Total joints		8429	5562	1083	671	884	158	71

* Includes weight of undissected tail.

H.P.

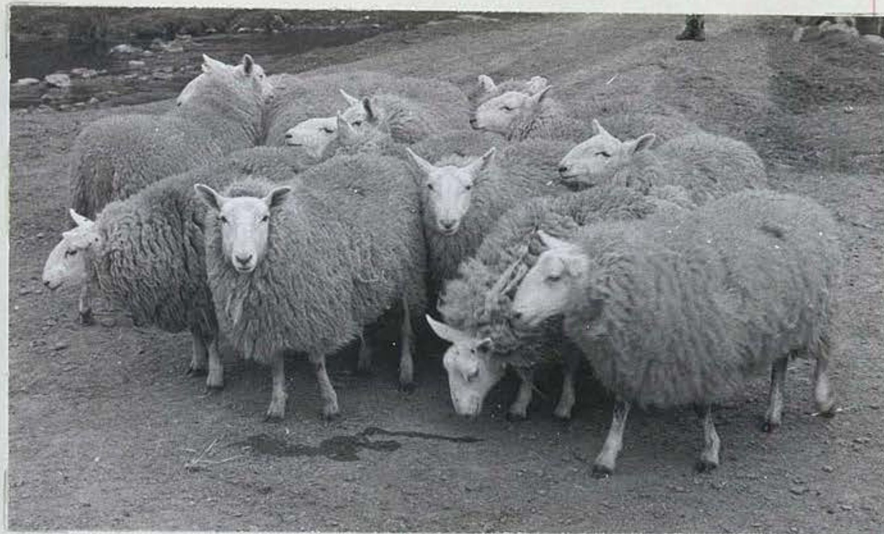


M.P.

L.P.

Plate 1

S.C.C. groups born 1956 at 50 weeks of age, at end of treatment period.



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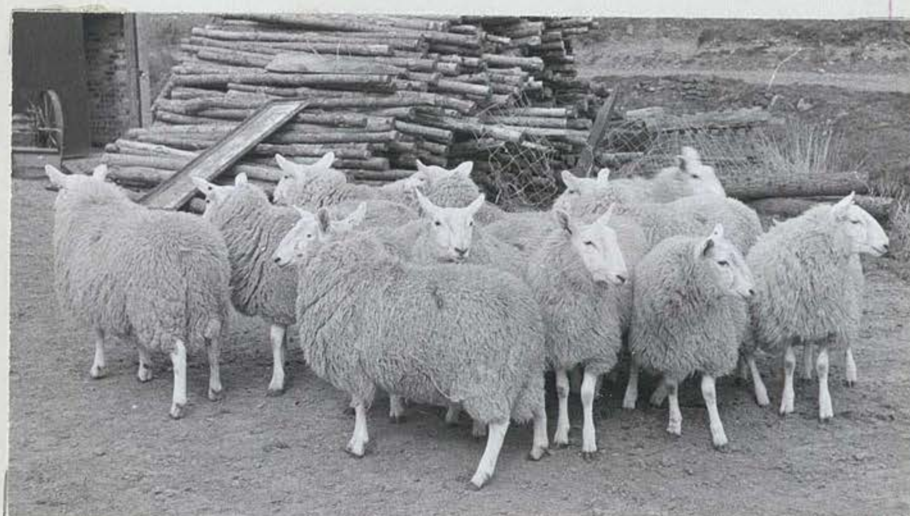

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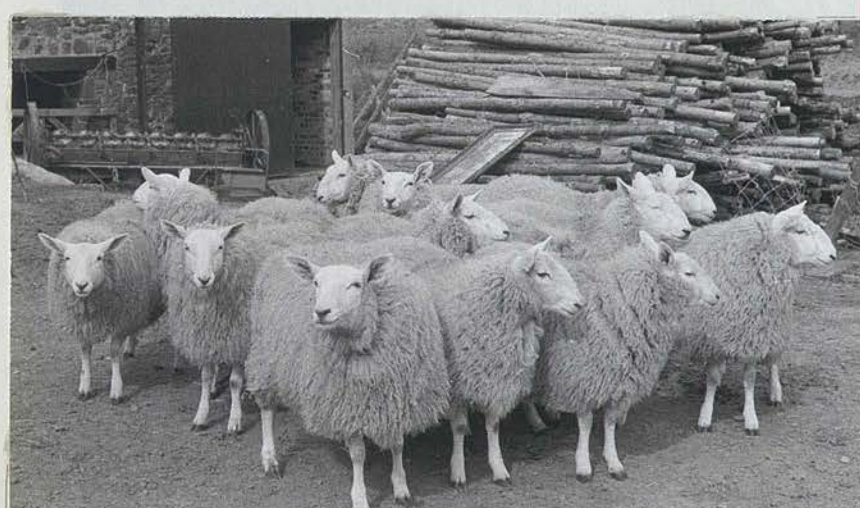
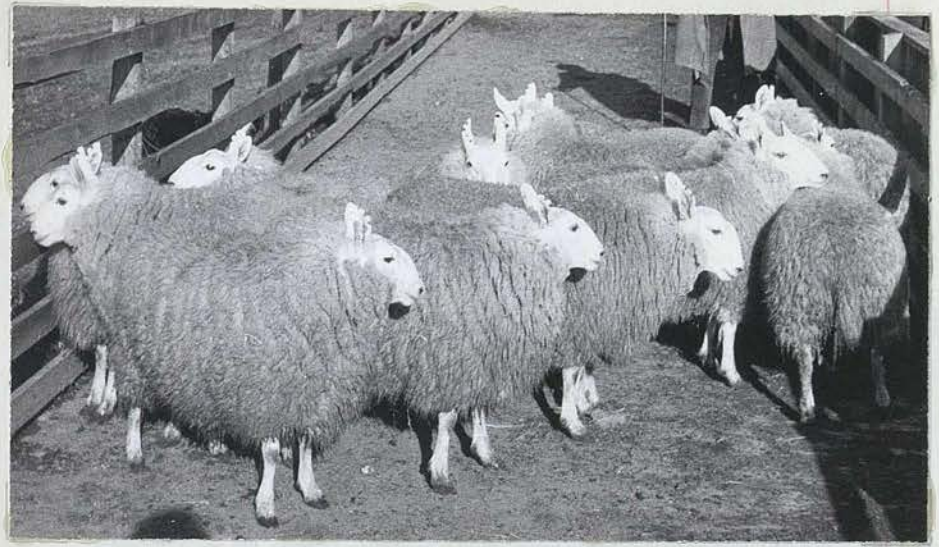


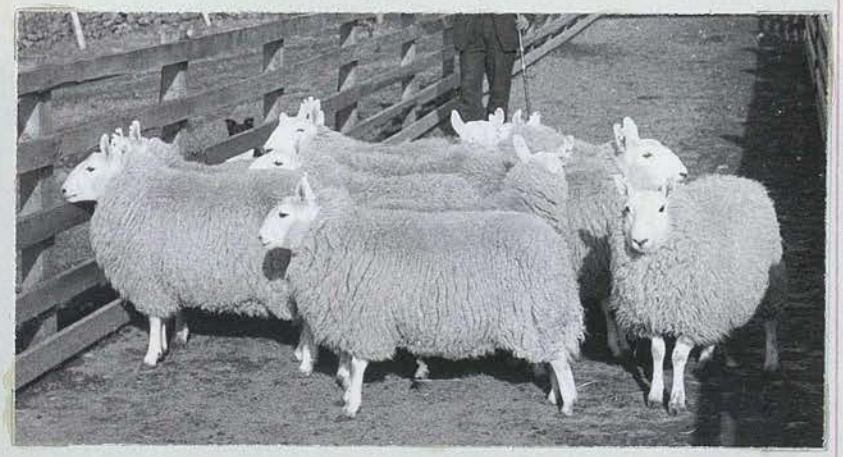
L.P.

Plate 2

N.C.C. groups born 1956 at 50 weeks of age, at end of treatment period.



H.P.

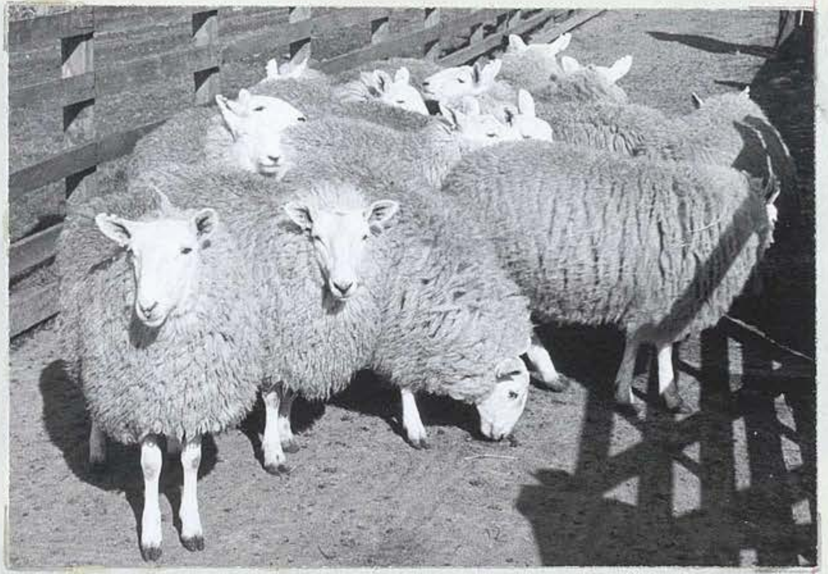


M.P.

HILL

Plate 3

S.C.C. groups born 1957 at 50 weeks of age, at end of treatment period.



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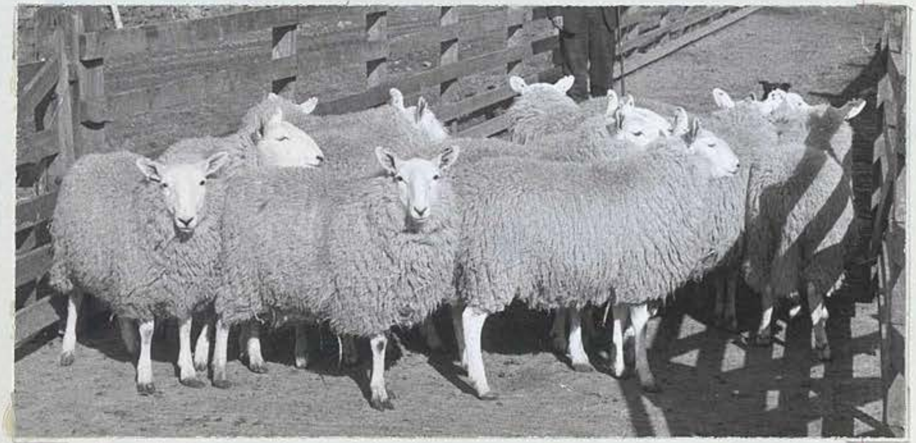
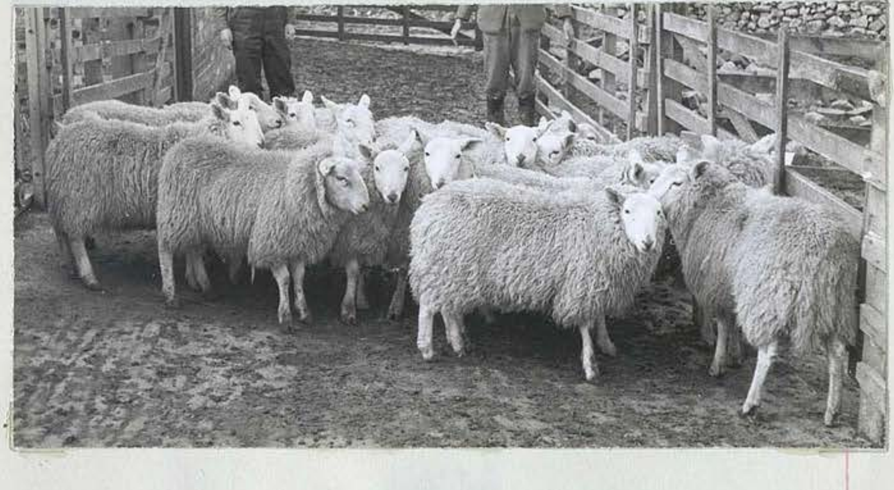


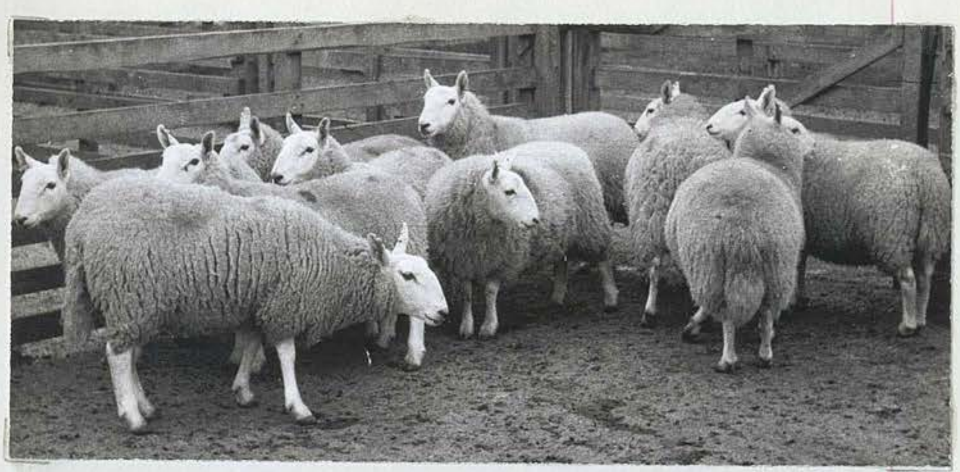
M.P.



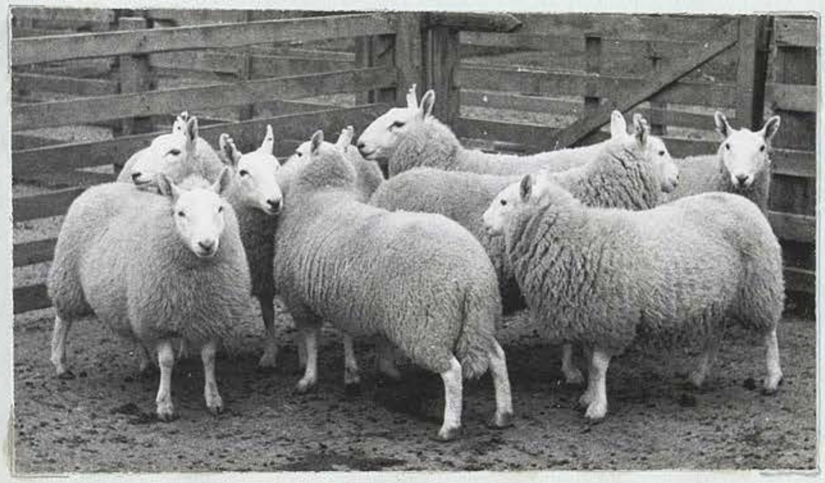
HILL

Plate 4

N.C.C. groups born 1957 at 50 weeks of age, at end of treatment period.



H.P.



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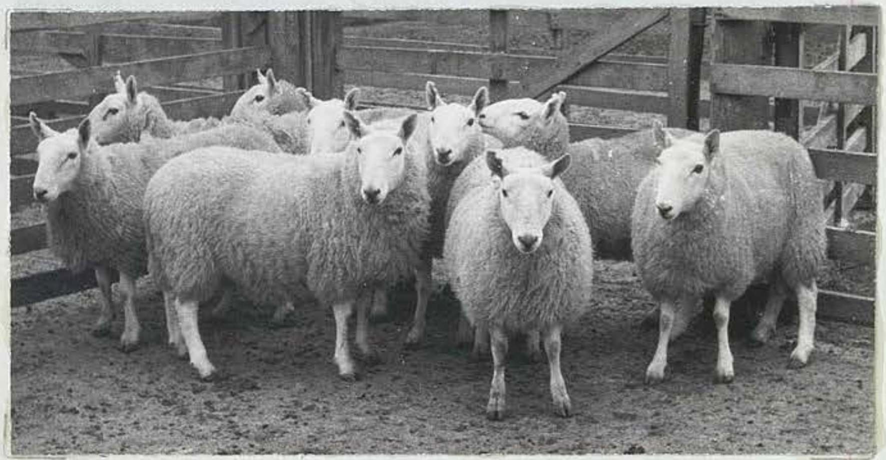
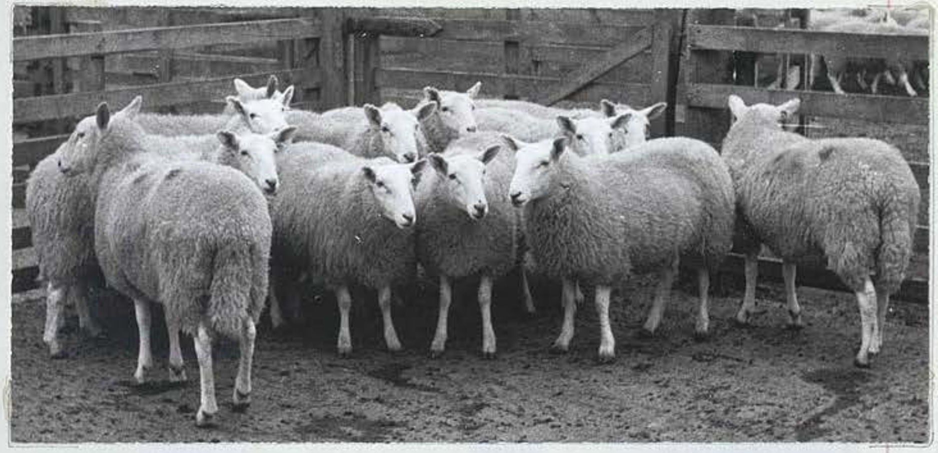


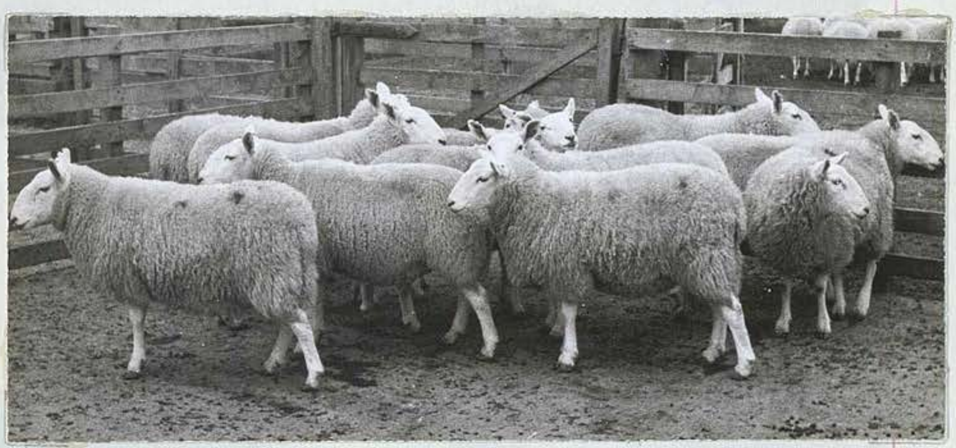
HILL

Plate 5

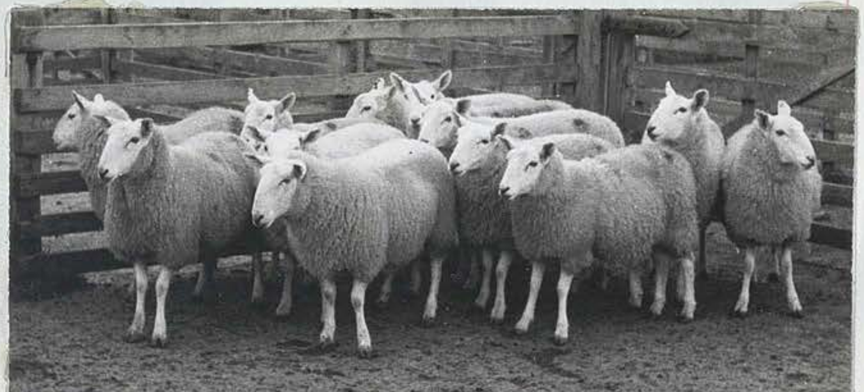
S.C.C. groups born 1957 at 80 weeks of age.



H.P.



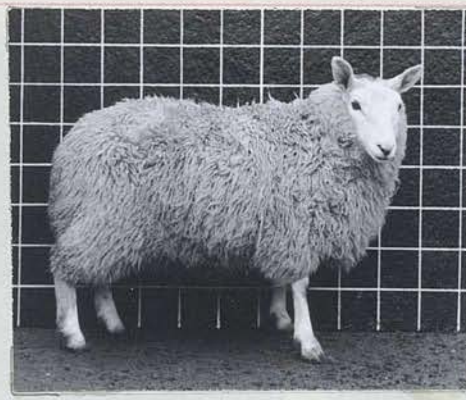
M.P.

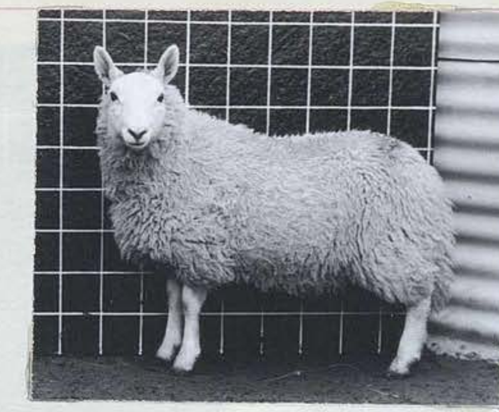


HILL

Plate 6

N.C.C. groups born 1957 at 80 weeks of age.

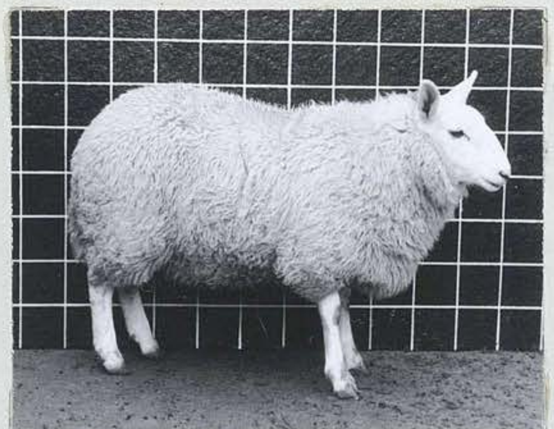


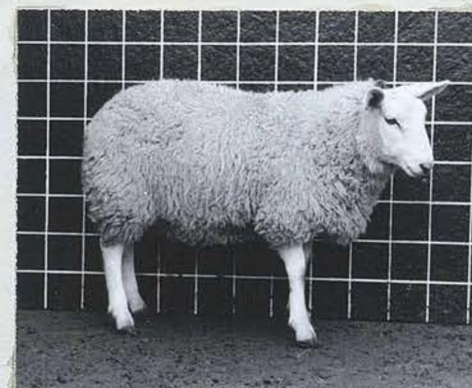


S.C.C.

C.535

C.530





N.C.C.

A.377

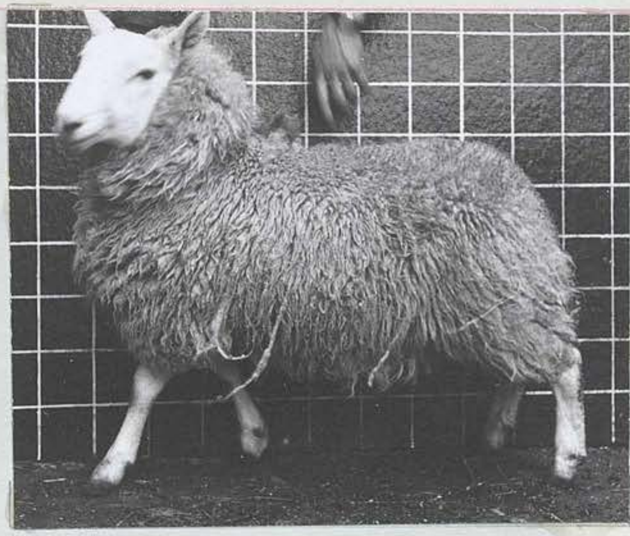
A.381

Plate 7

Animals born 1956 and selected for dissection at 29 weeks, pre-treatment.

H.P. M.P. L.P.

C.520

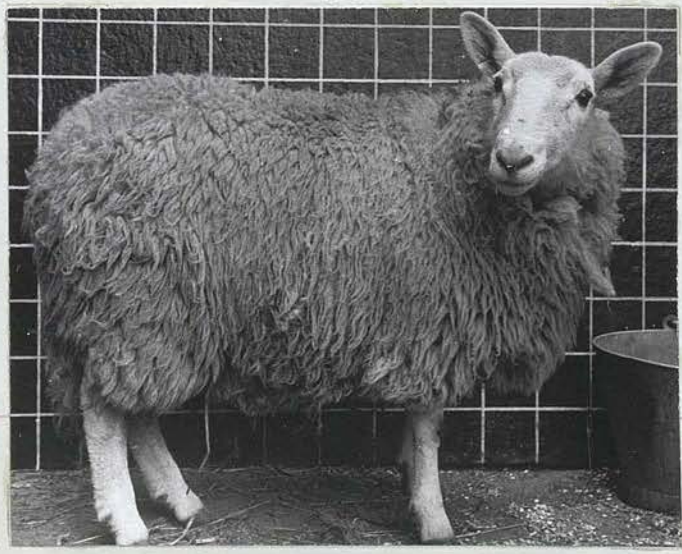


C.510

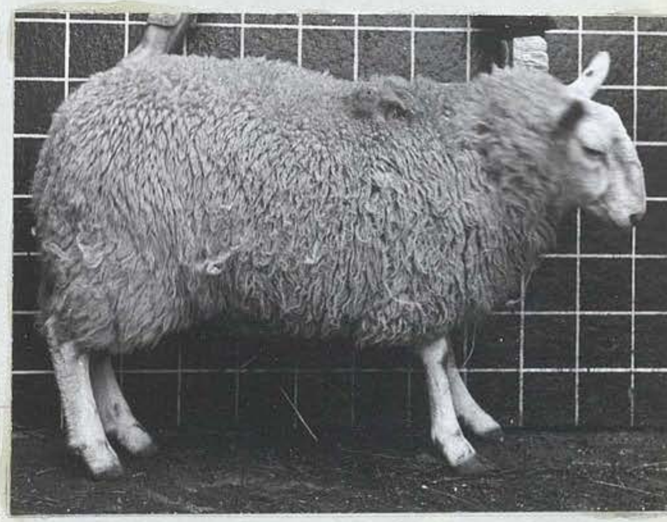
C.502

N.C.C.

A.384



A.370



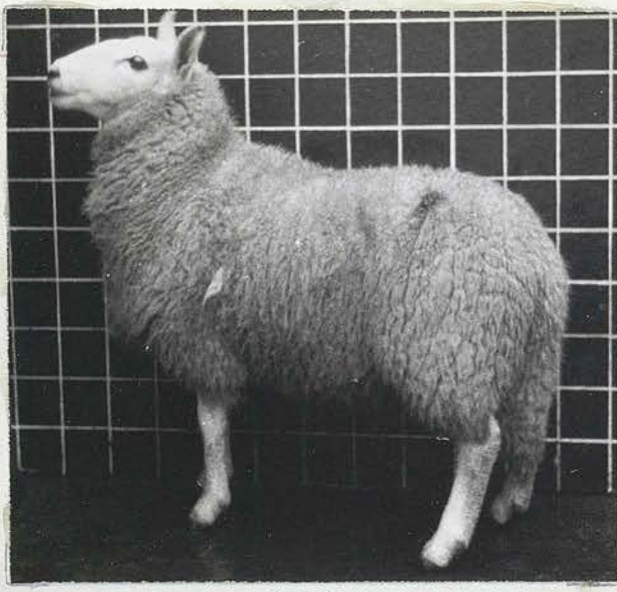
A.362

Plate 8

Animals born 1956 and selected for dissection at 50 weeks, at end of treatment period.

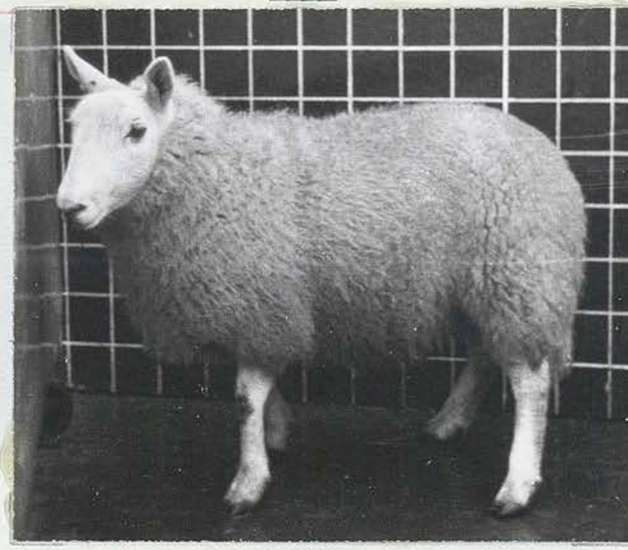
S.C.C.

H.P.



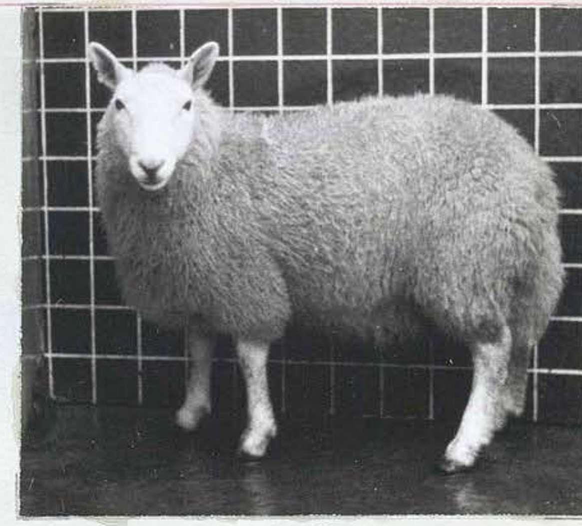
C.532

M.P.



C.537

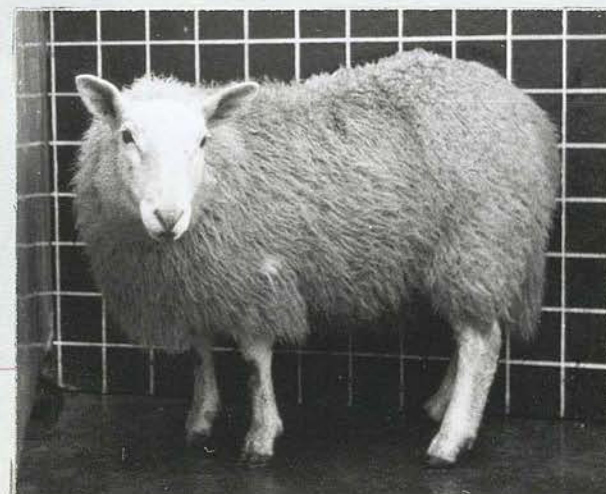
L.P.



C.507

N.C.C.

A.364

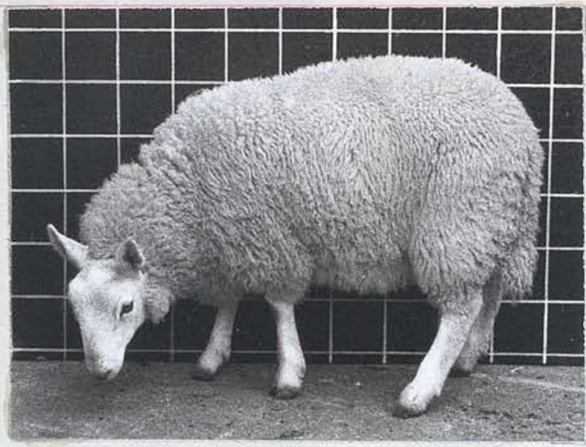


A.408

A.365

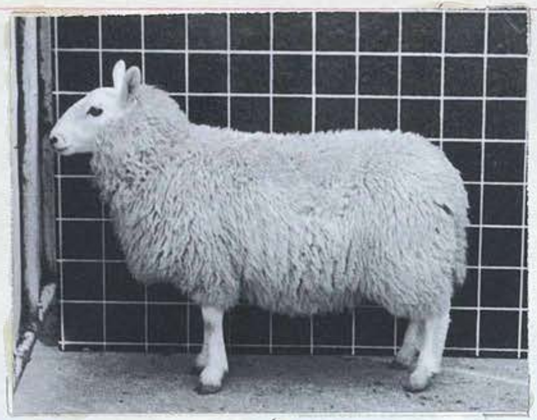
Plate 9

Animals born 1956 and selected for dissection at 81 weeks.

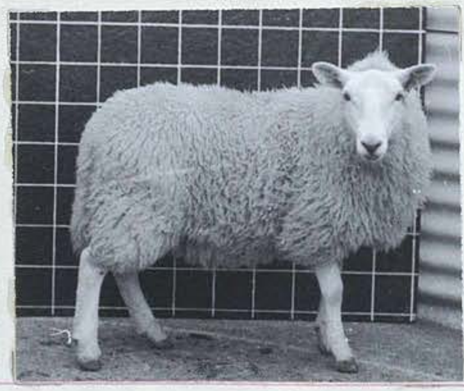


C.23

S.C.C.

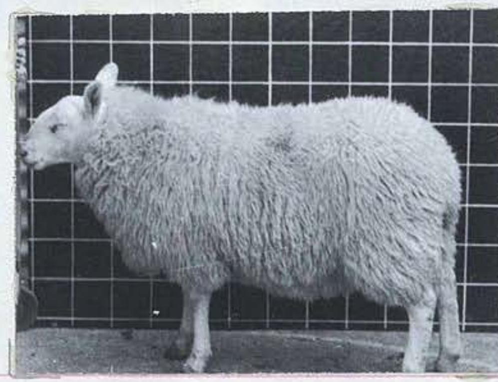


C.124



N.68

N.C.C.



N.4

Plate 10

Animals born 1957 and selected for dissection at 24 weeks, pre-treatment.

S.C.C.

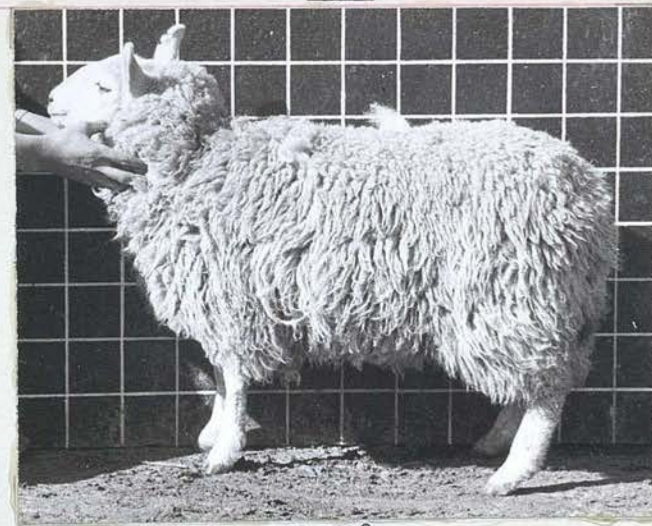
H.P.

C.710

M.P.

C.720

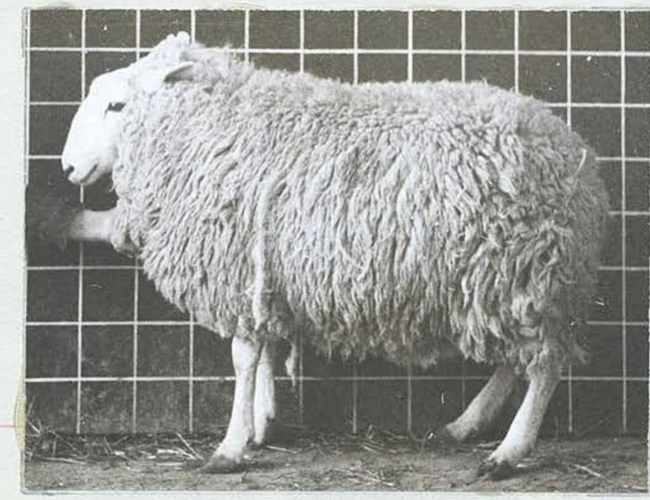
HILL



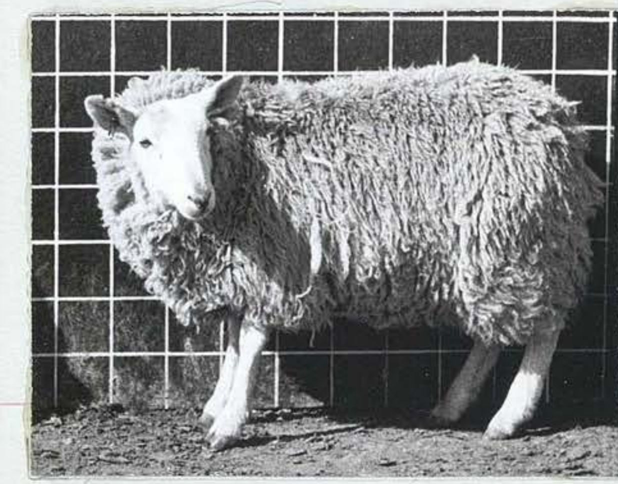
C.708

N.C.C.

A.727



A.713



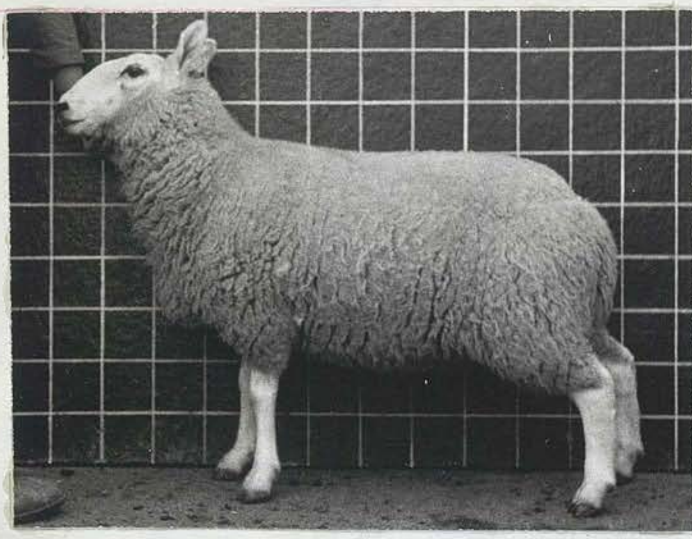
A.708

Plate 11

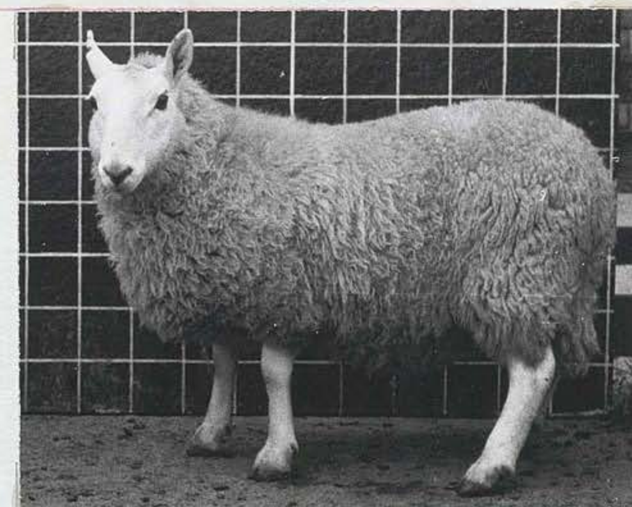
Animals born 1957 and selected for dissection at 50 weeks, at end of treatment period.

S.C.C.

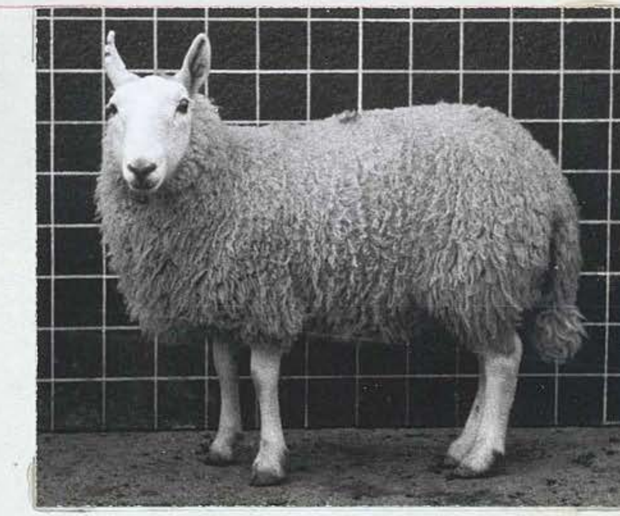
H.P. | M.P. | HILL



C.717

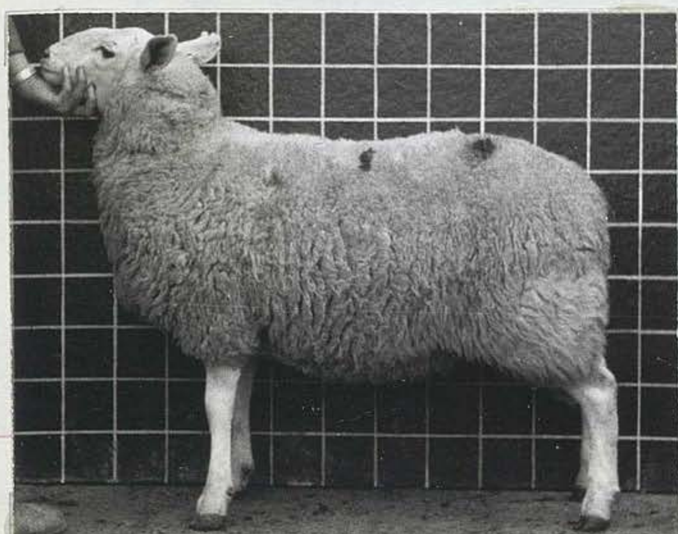


C.703



C.719

N.C.C.



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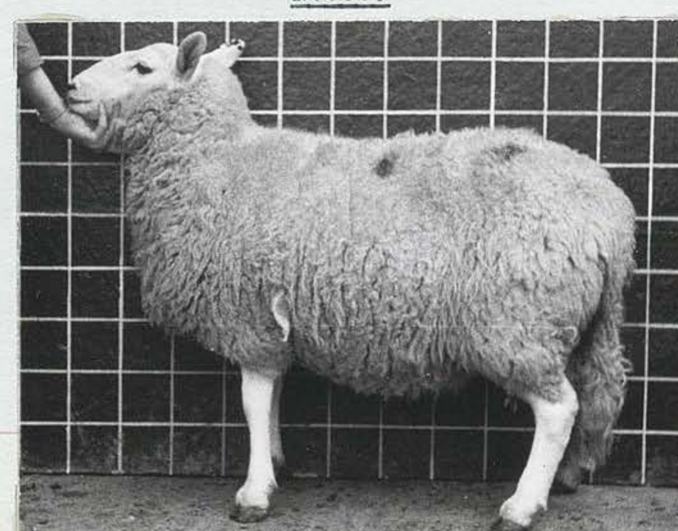
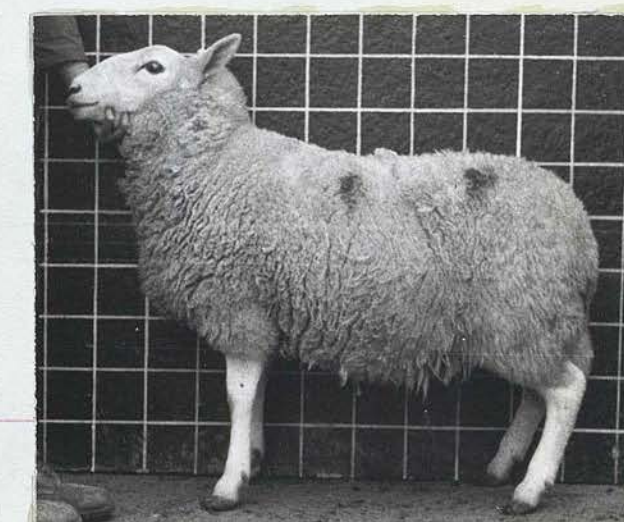


A.719



A.723

Plate 12

Animals born 1957 and selected for dissection at 80 weeks.

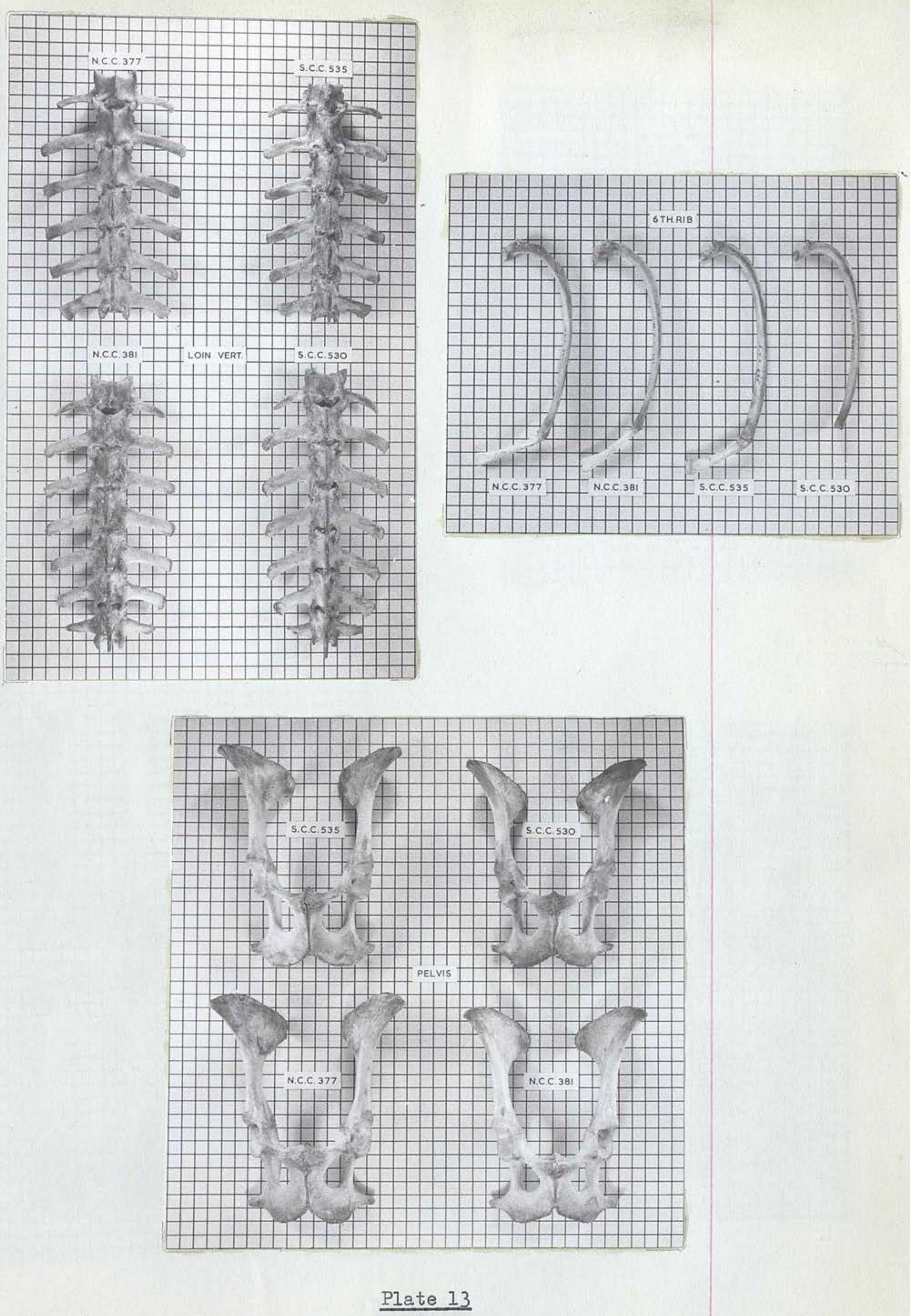
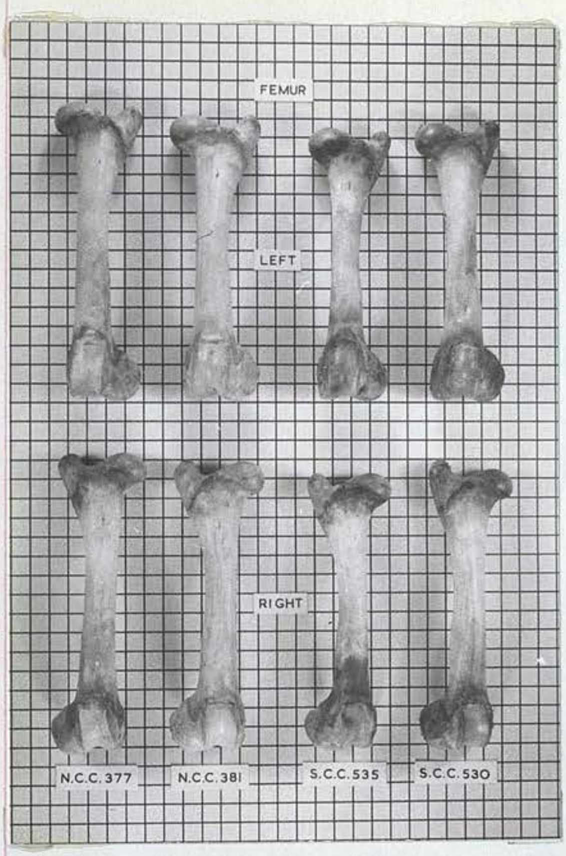
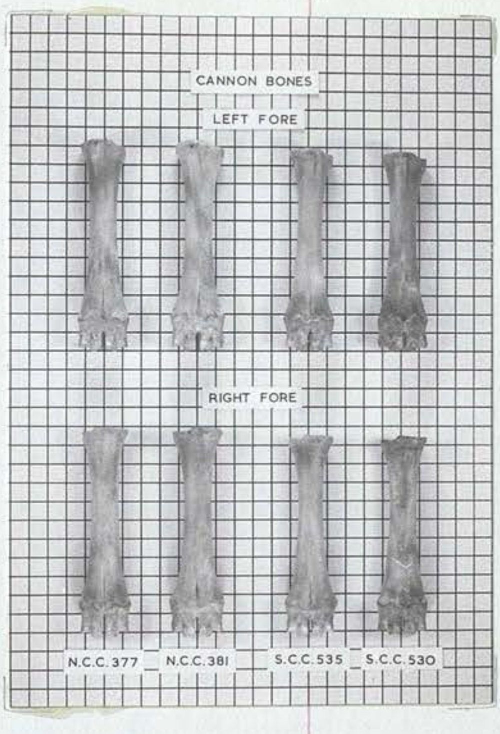
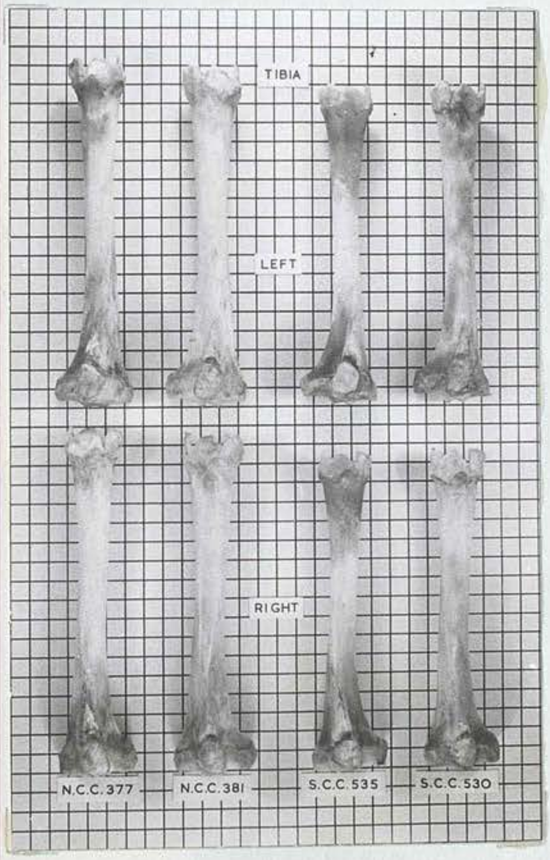


Plate 13

Bones from animals born 1956 and dissected at 29 weeks, pre-treatment.







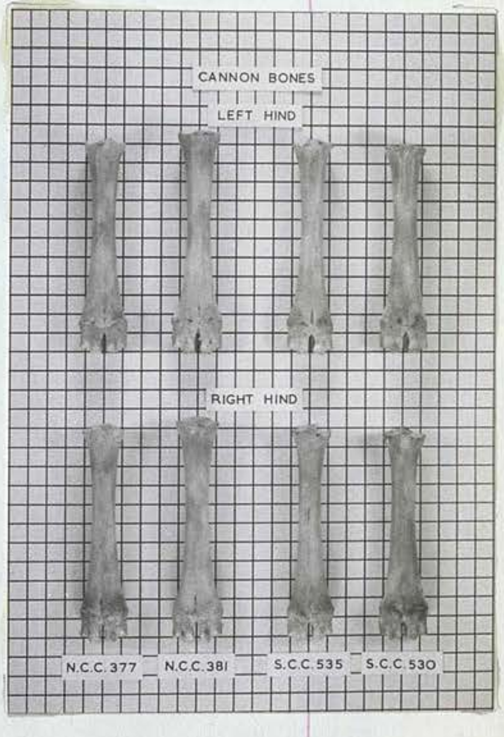
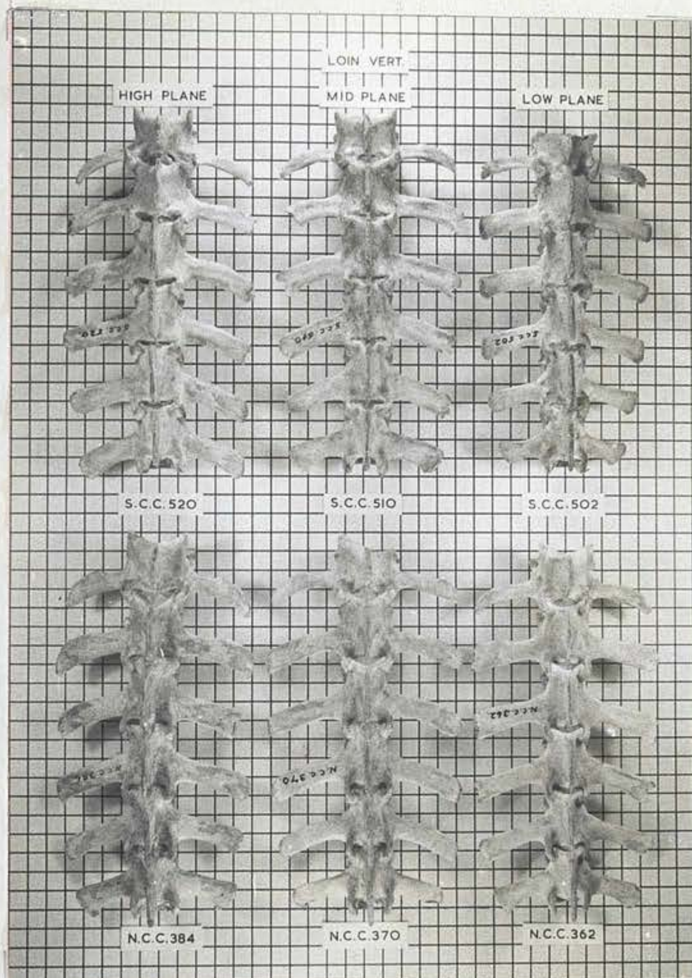


Plate 13A

Bones from animals born 1956 and dissected at 29 weeks, pre-treatment.



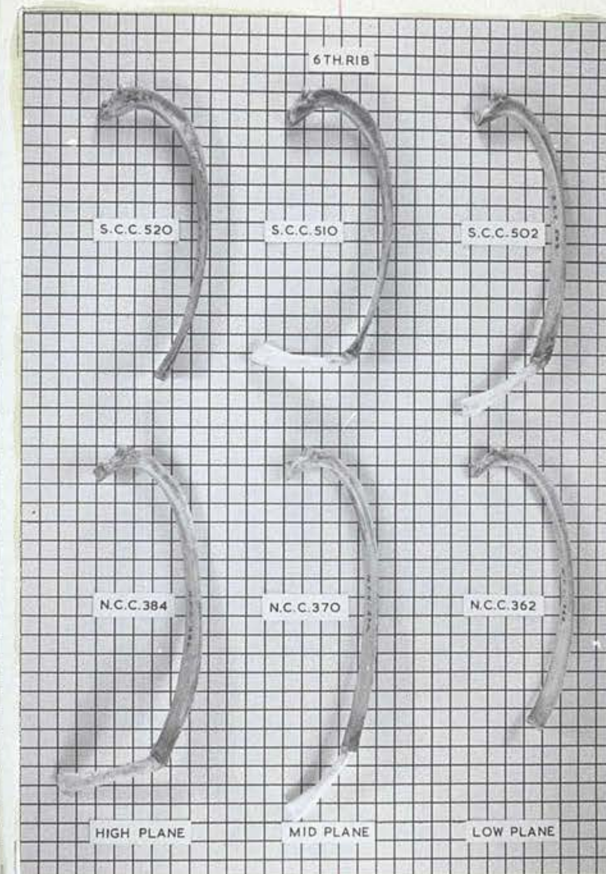
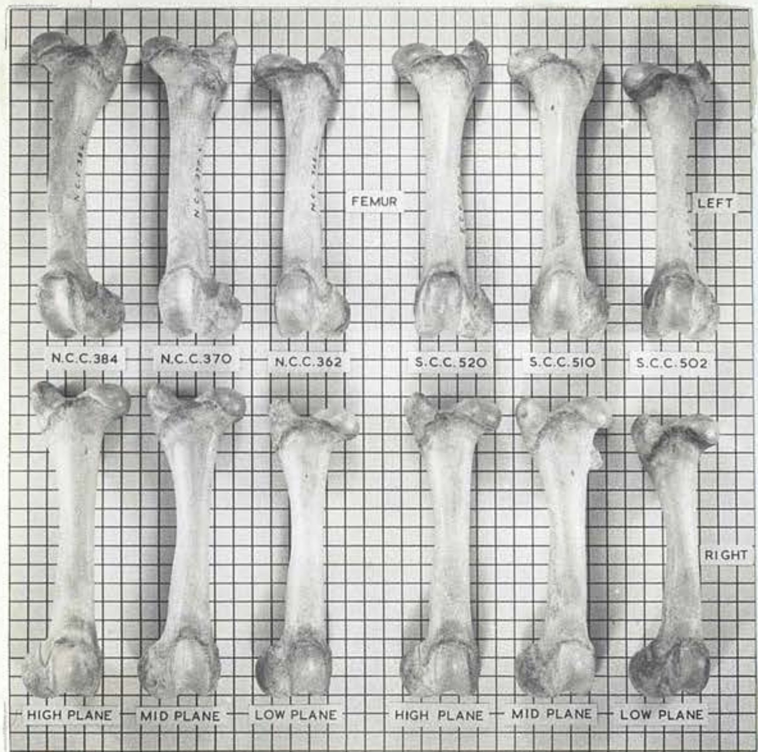
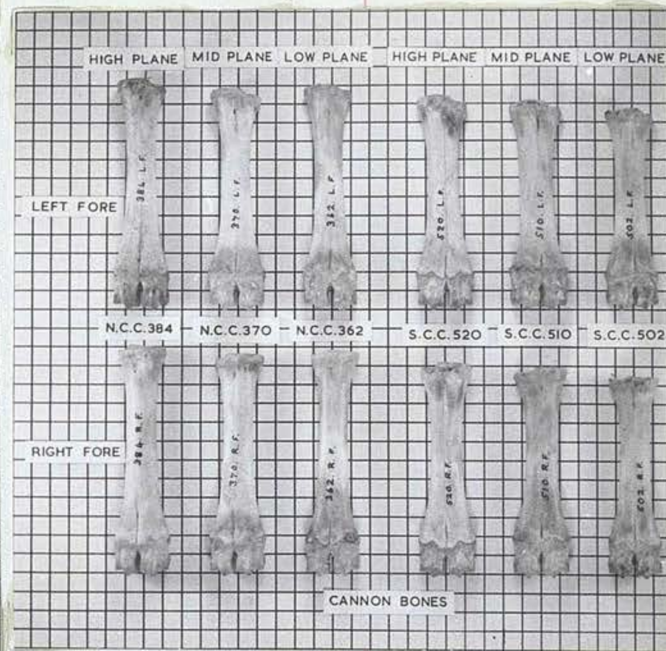
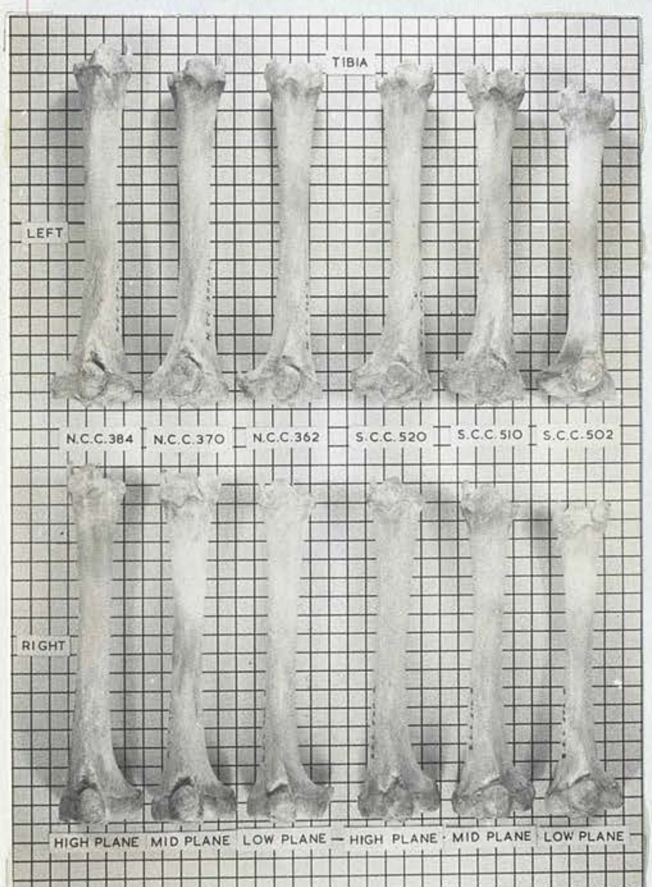


Plate 14

Bones from animals born 1956 and dissected at 50 weeks, at end of treatment period.







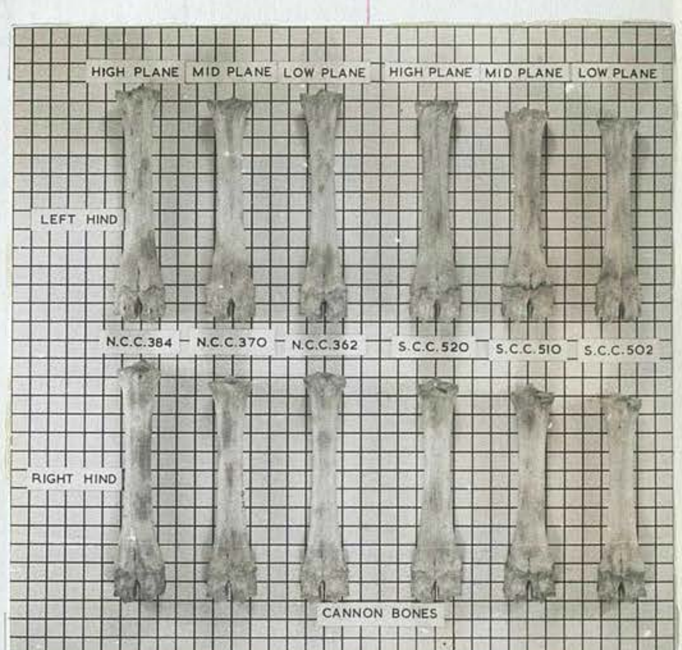
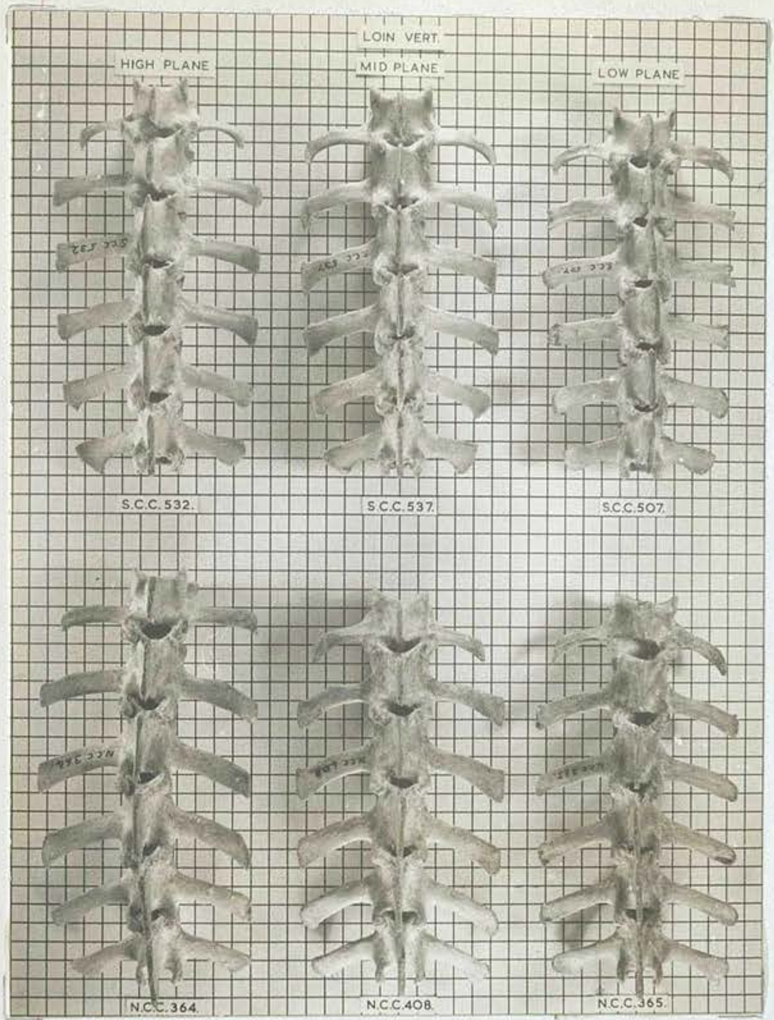
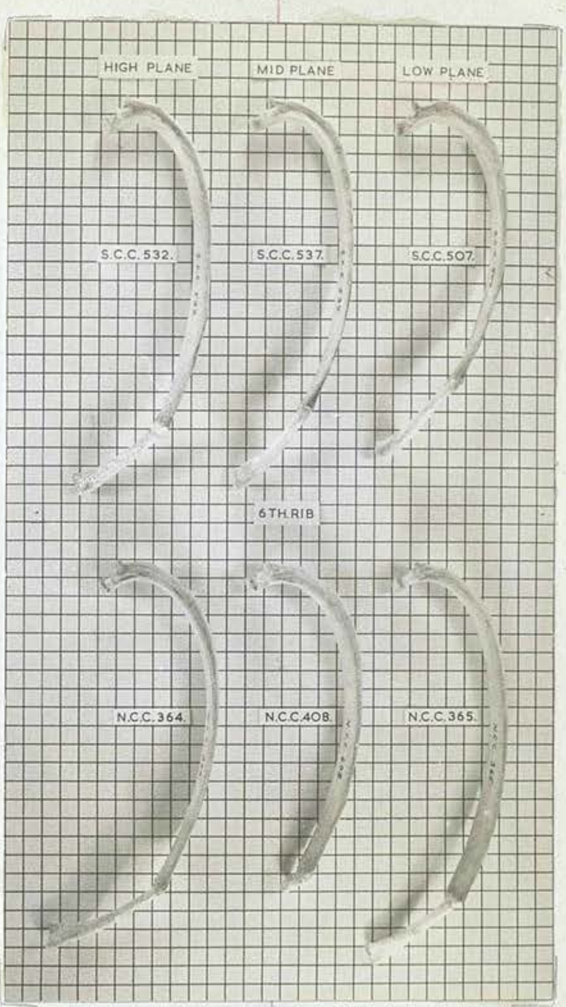


Plate 14A

Bones from animals born 1956 and dissected at 50 weeks, at end of treatment period.





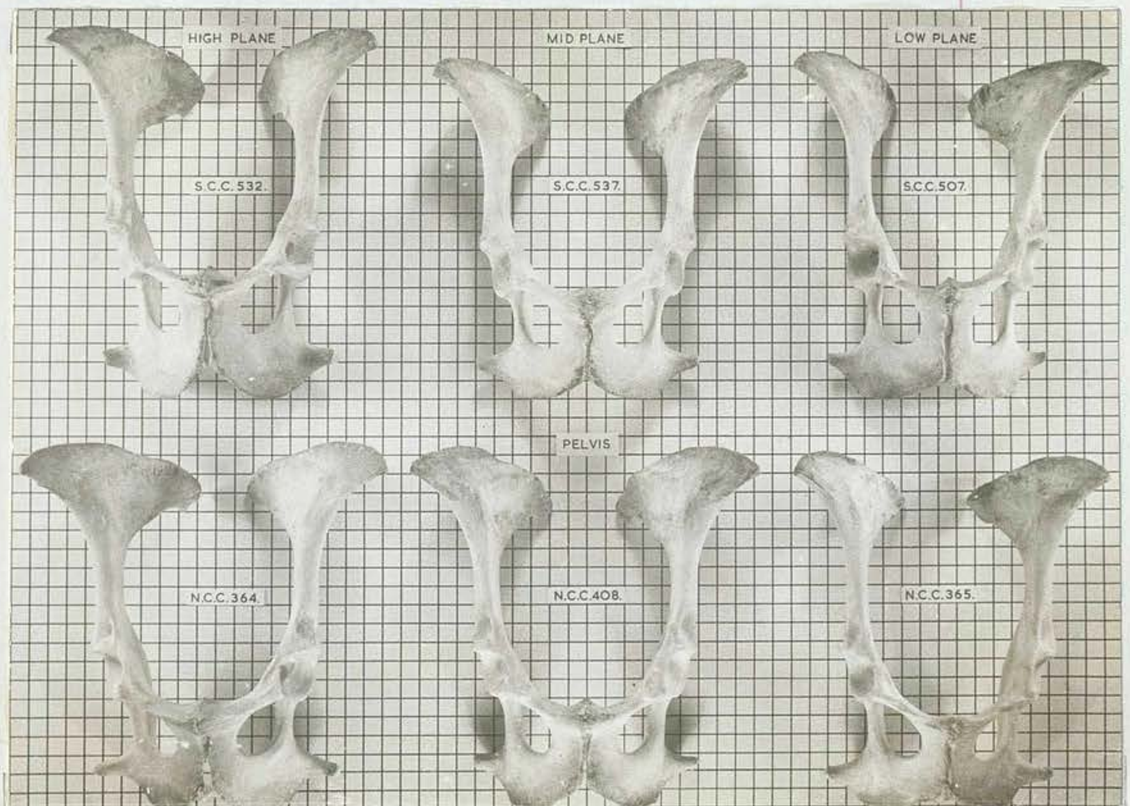
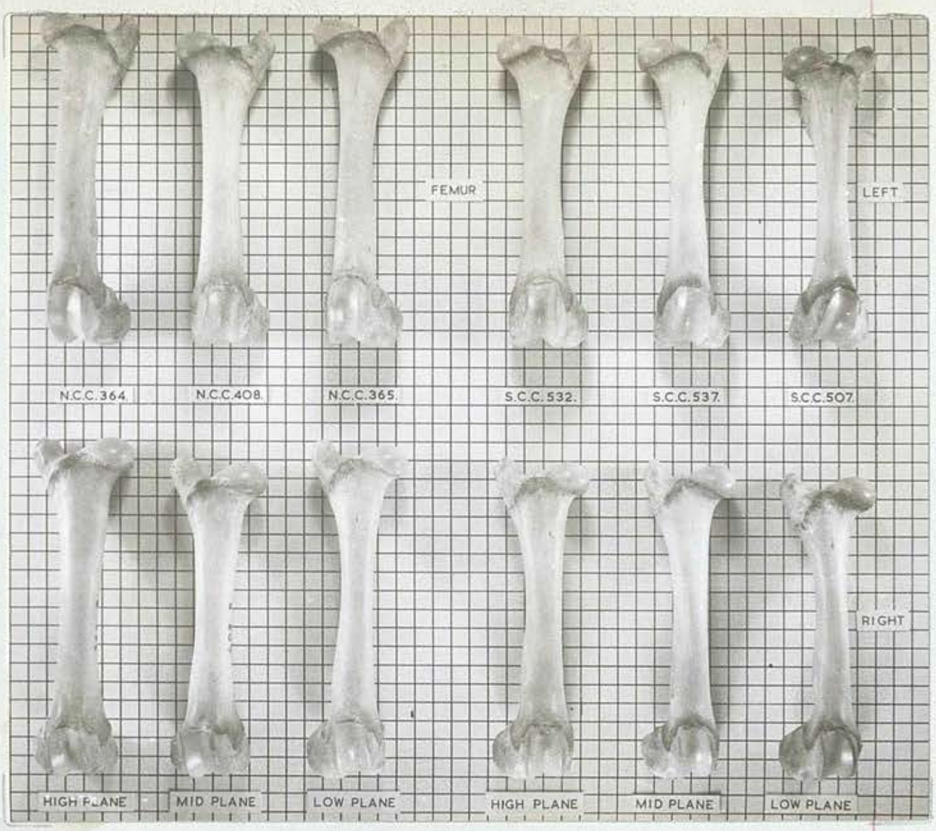


Plate 15

Bones from animals born 1956 and dissected at 81 weeks.



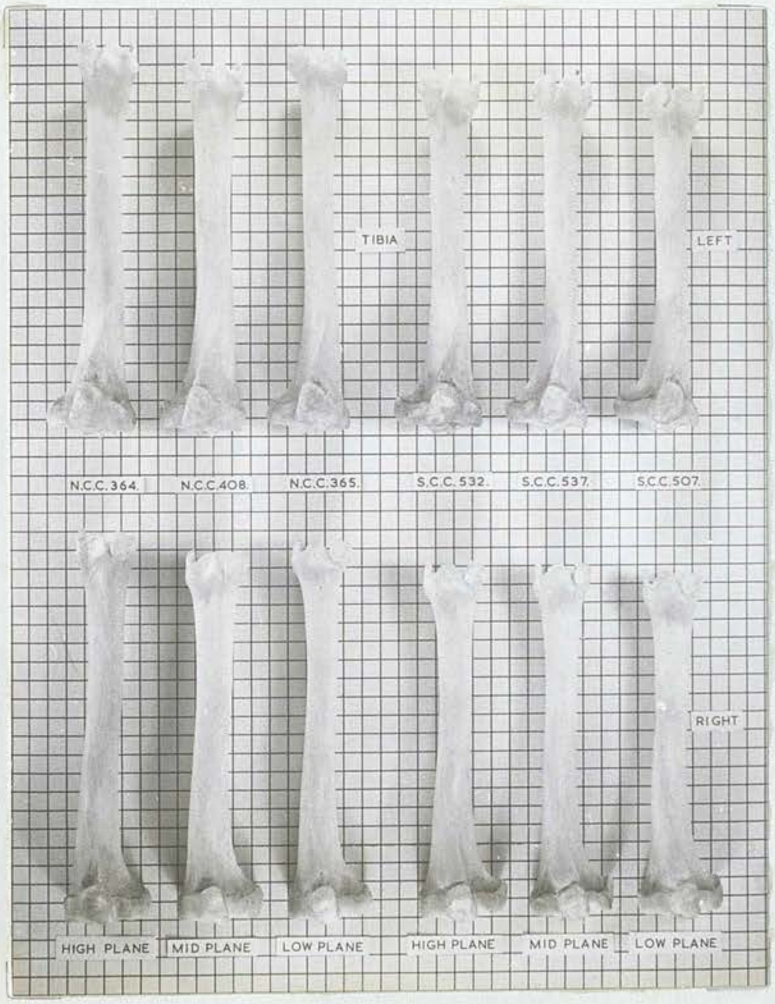
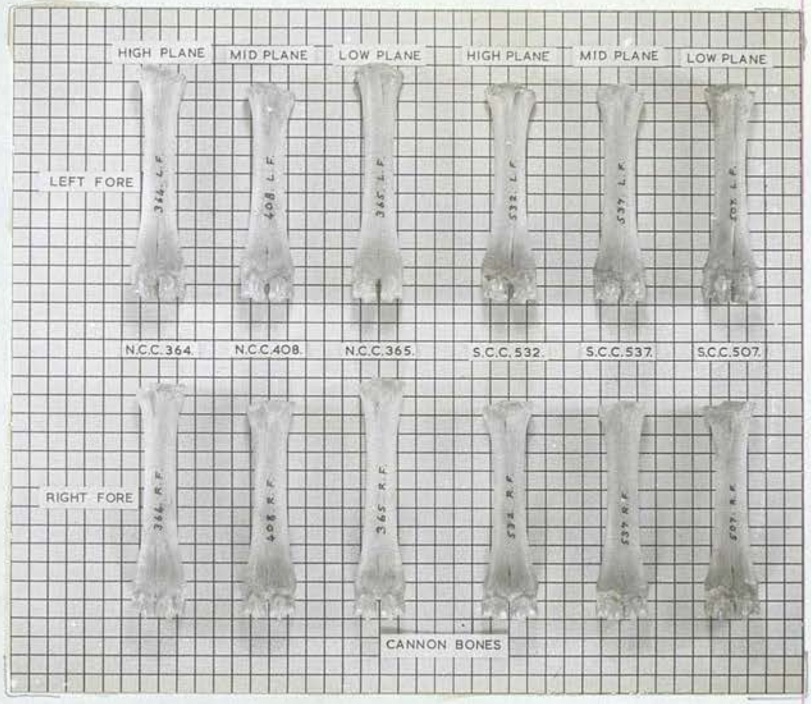


Plate 15A

Bones from animals born 1956 and dissected at 81 weeks.



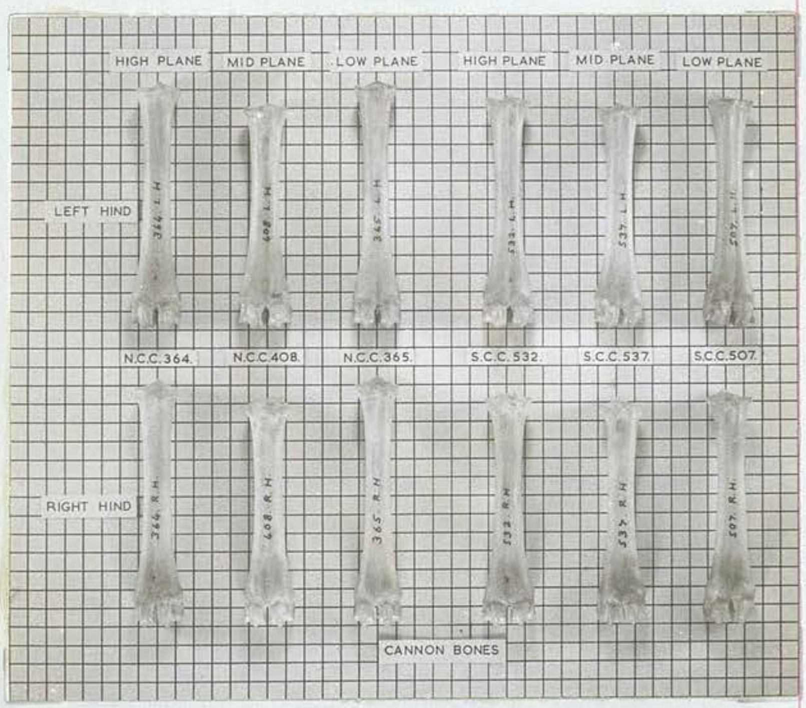
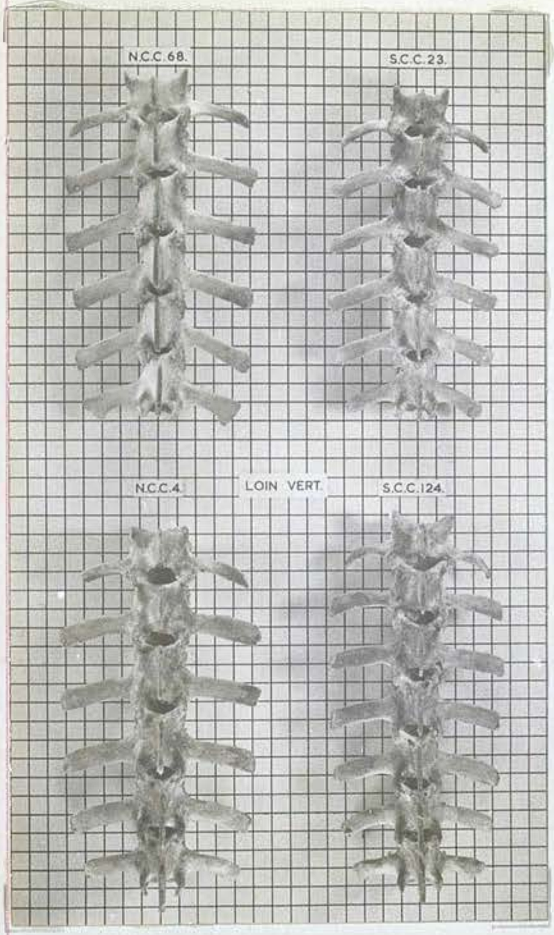
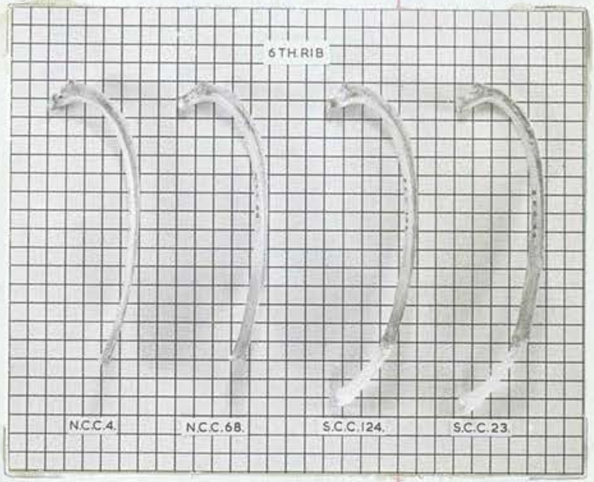


Plate 15B

Bones from animals born 1956 and dissected at 81 weeks.





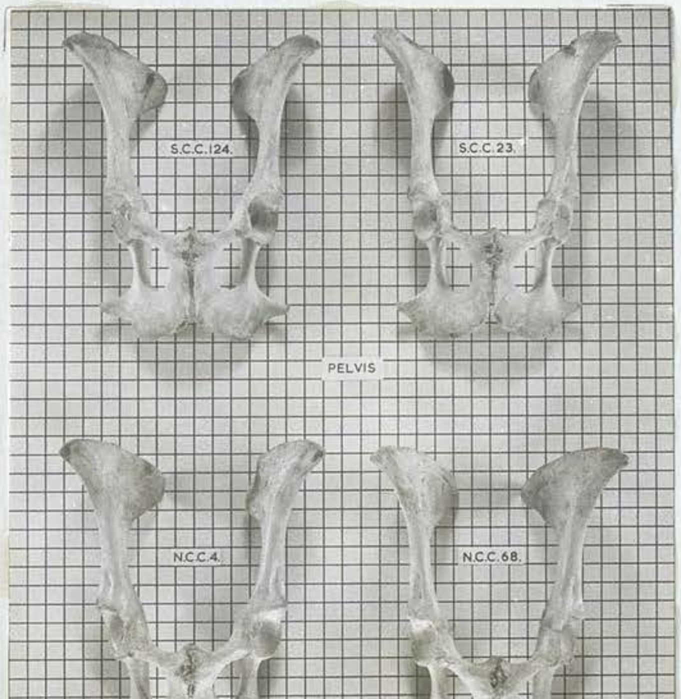


Plate 16

Bones from animals born 1957 and dissected at 24 weeks, pre-treatment.

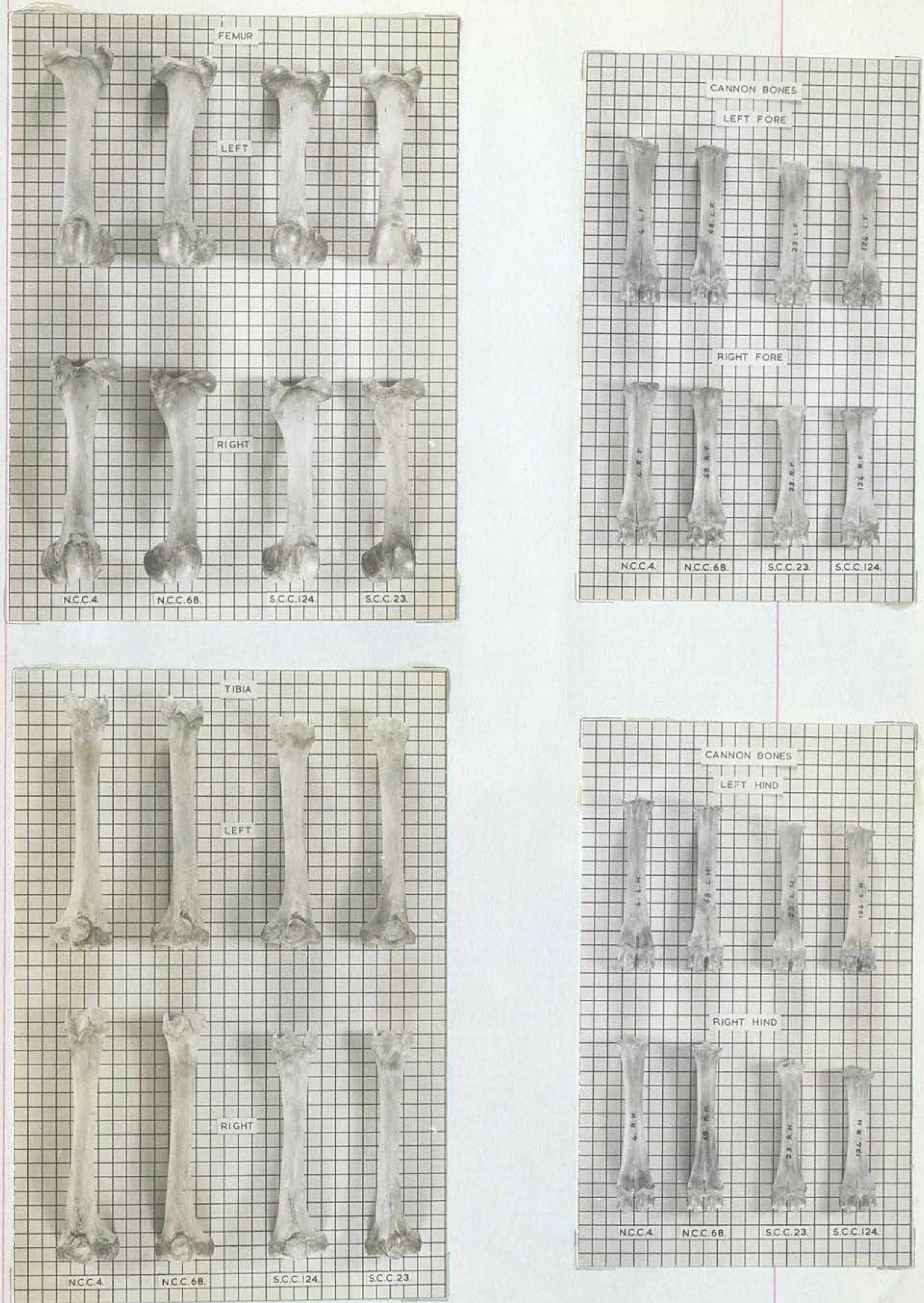
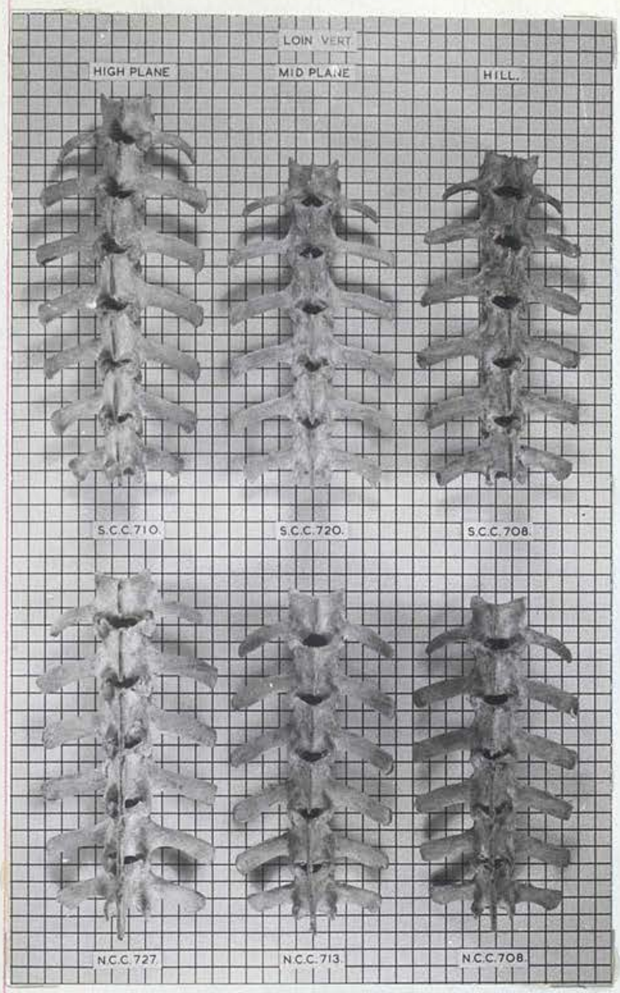
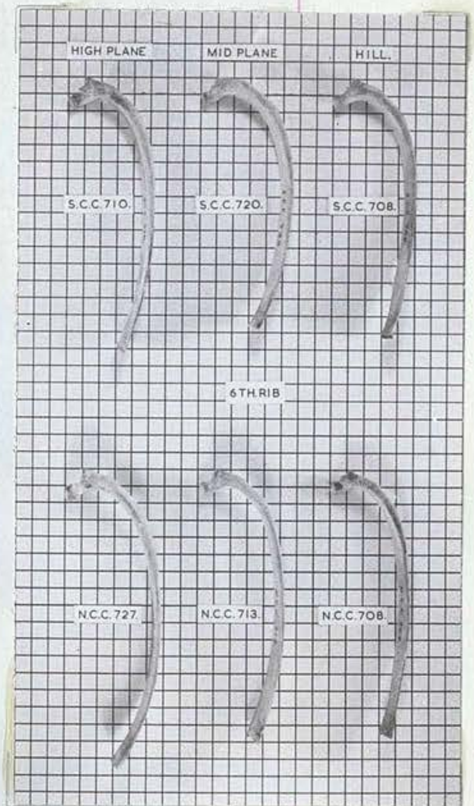


Plate 16A

Bones from animals born 1957 and dissected
at 24 weeks, pre-treatment.





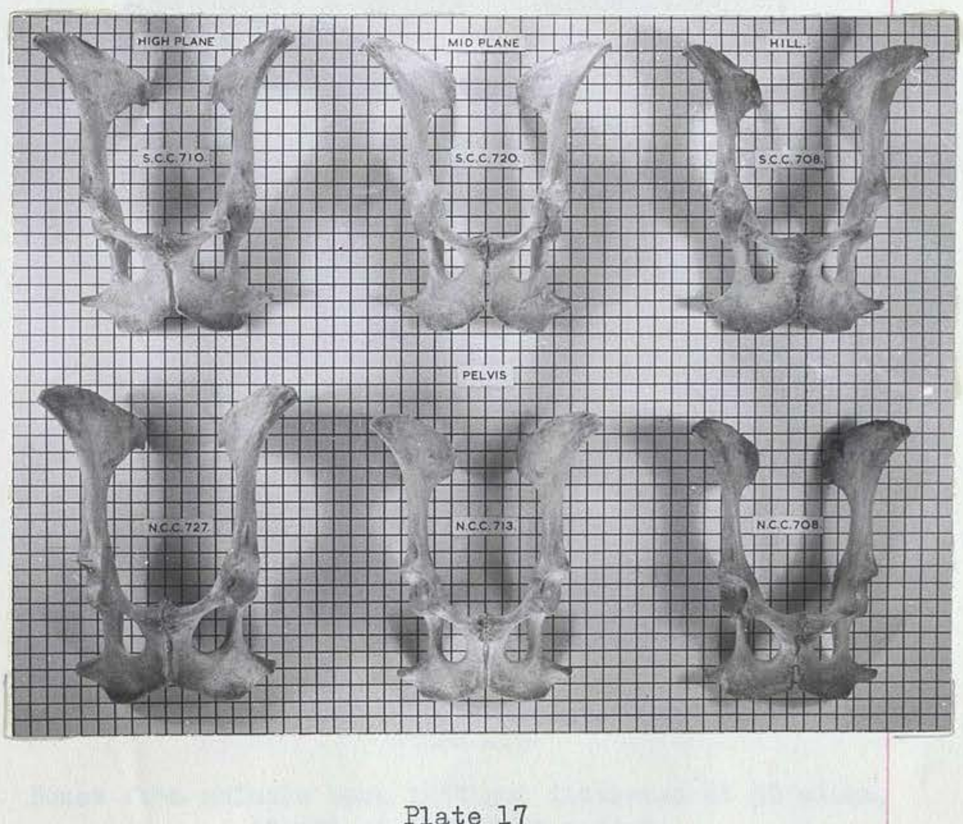
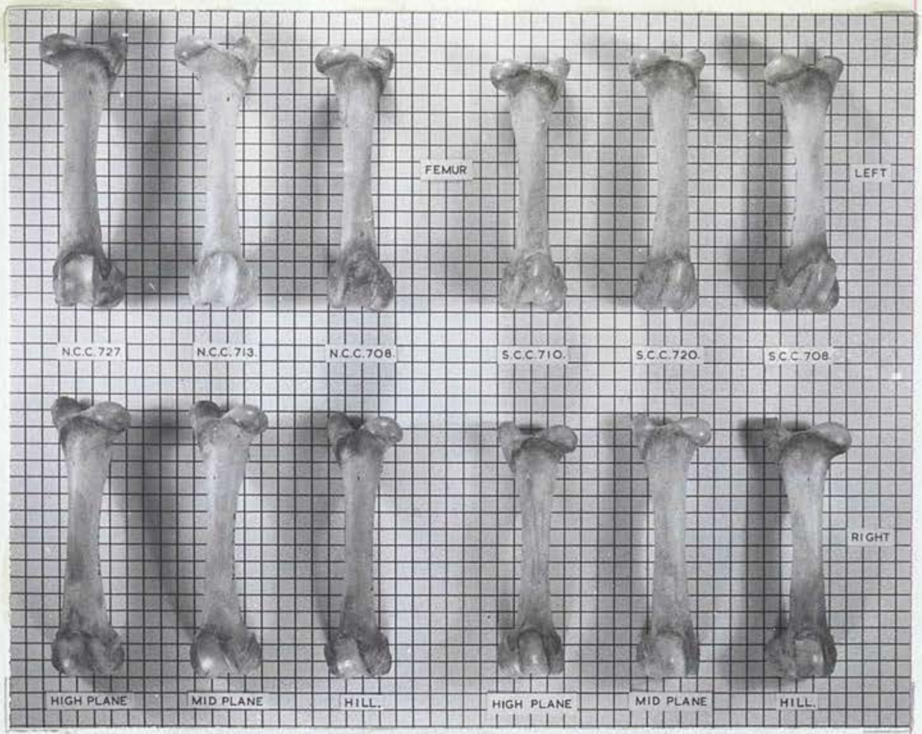


Plate 17

Bones from animals born 1957 and dissected at 50 weeks, at end of treatment period.



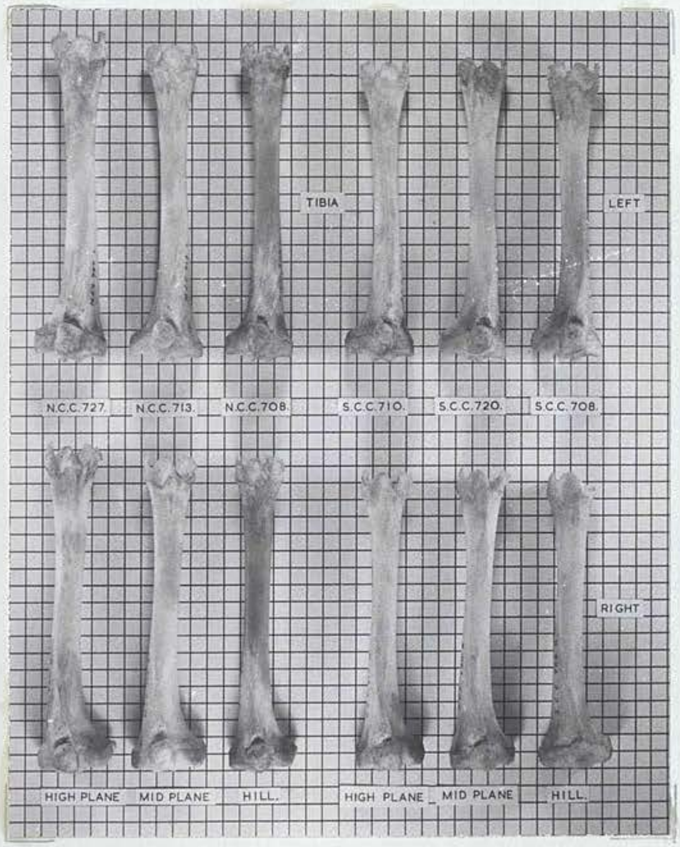
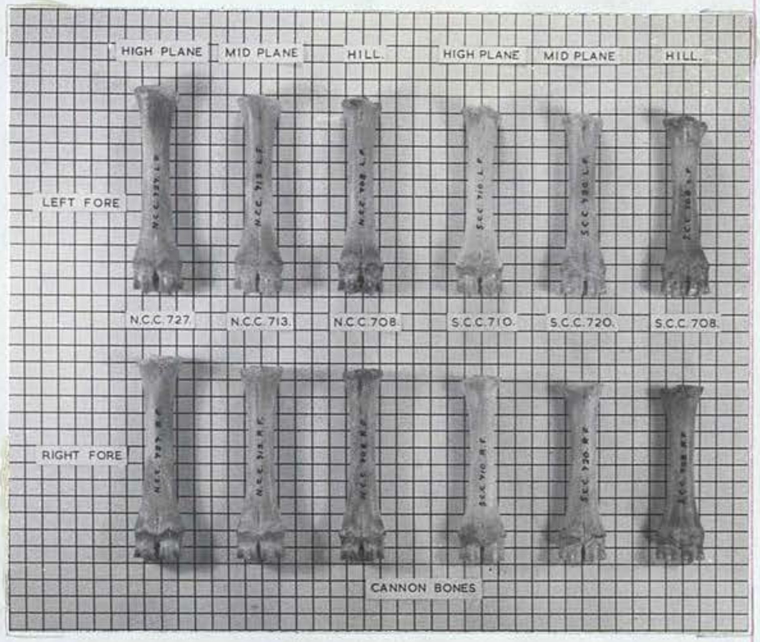


Plate 17A

Bones from animals born 1957 and dissected at 50 weeks, at end of treatment period.



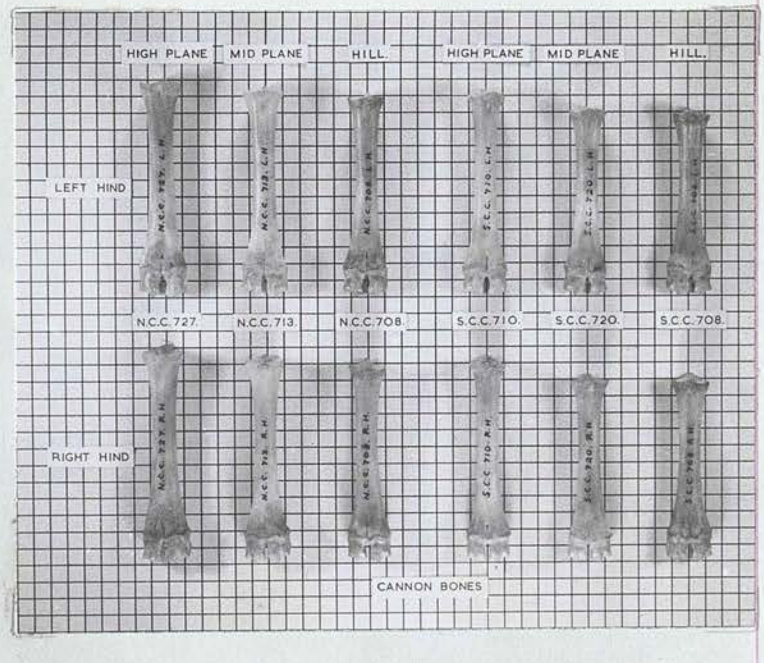
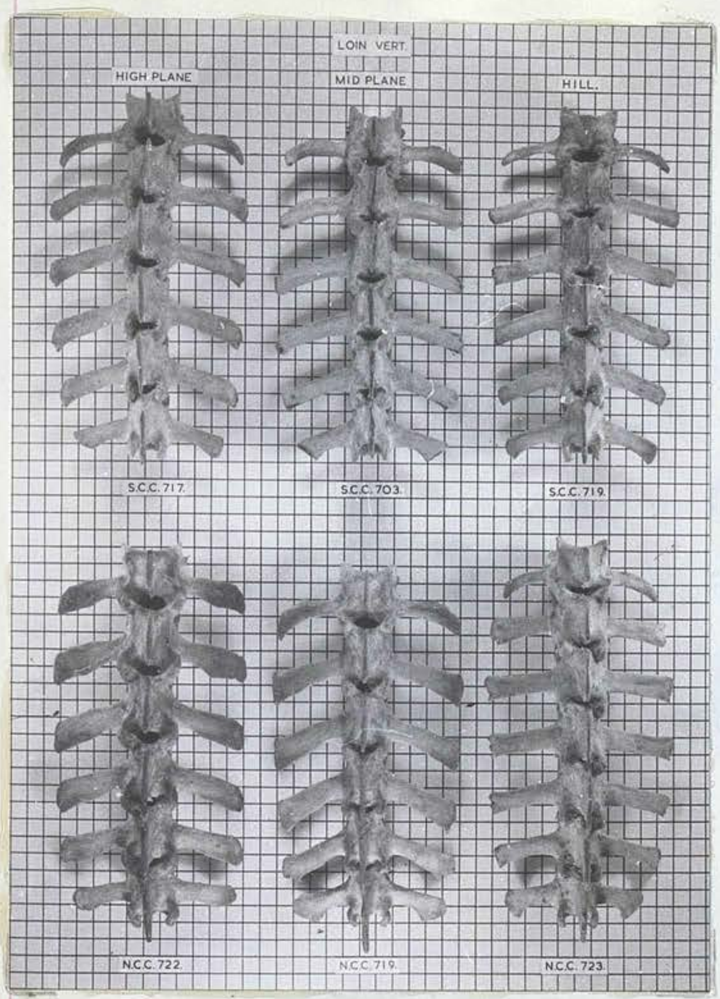
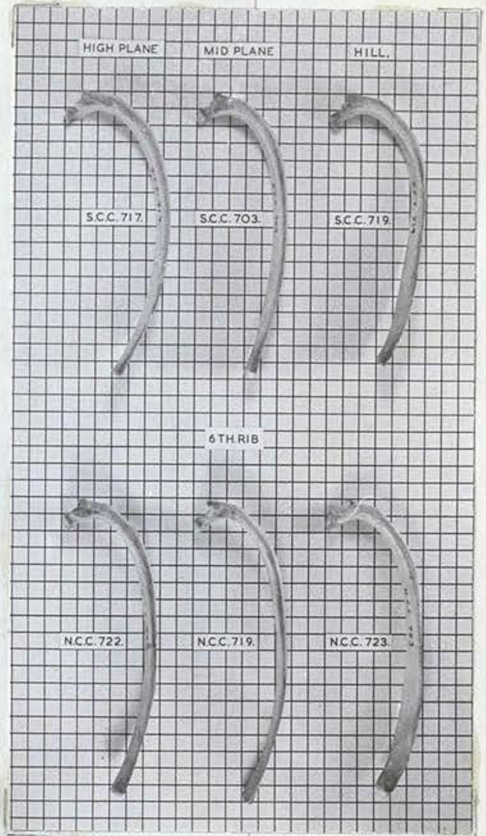


Plate 17B

Bones from animals born 1957 and dissected at 50 weeks, at end of treatment period.





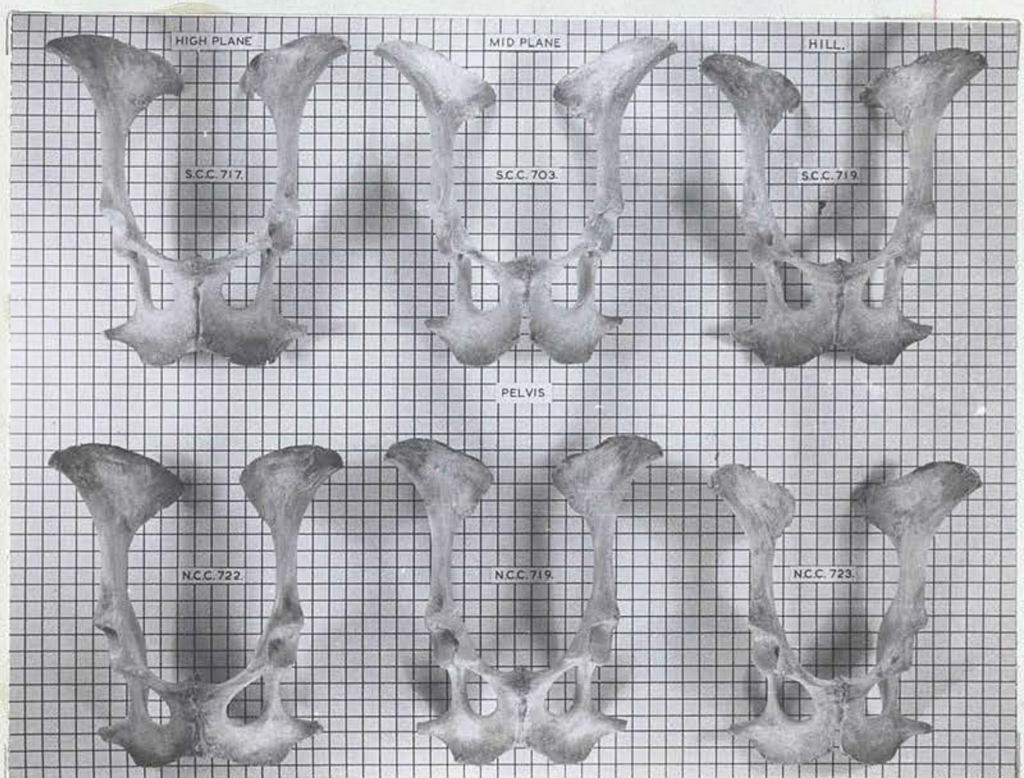
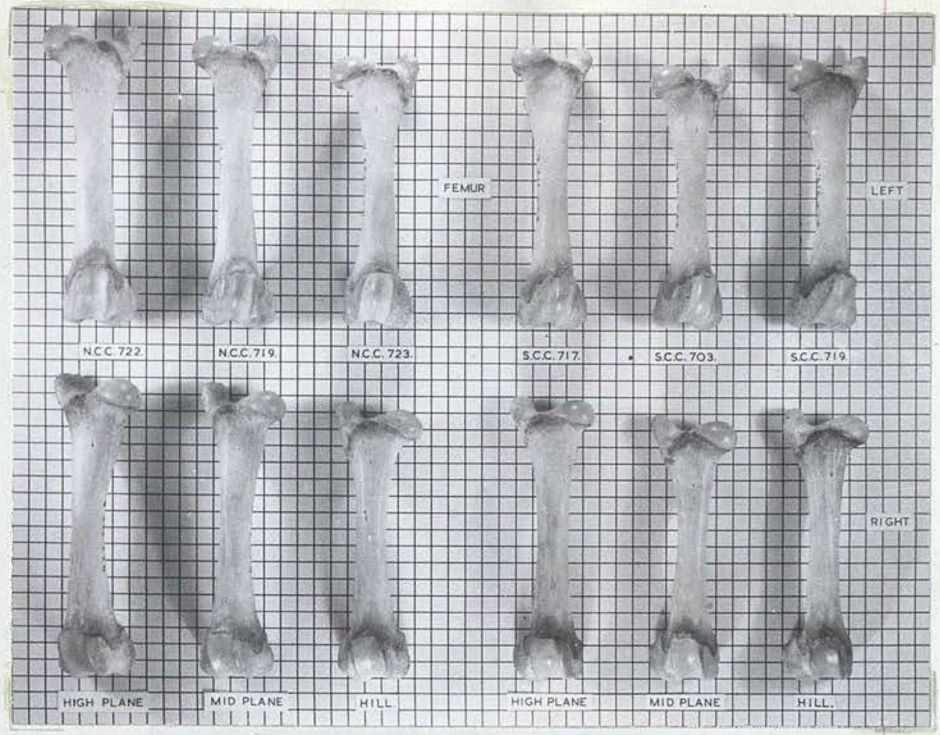


Plate 18

Bones from animals born 1957 and dissected at 80 weeks.



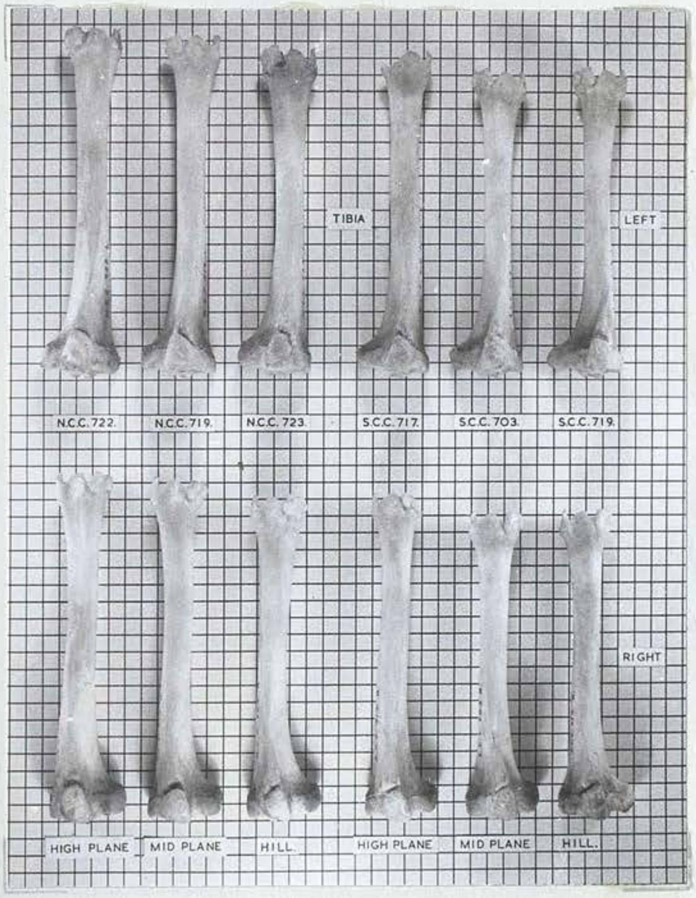
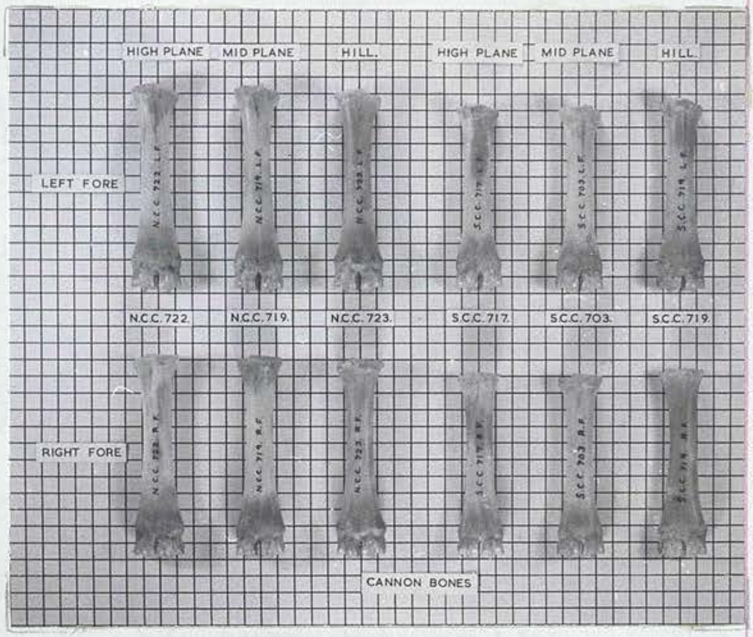
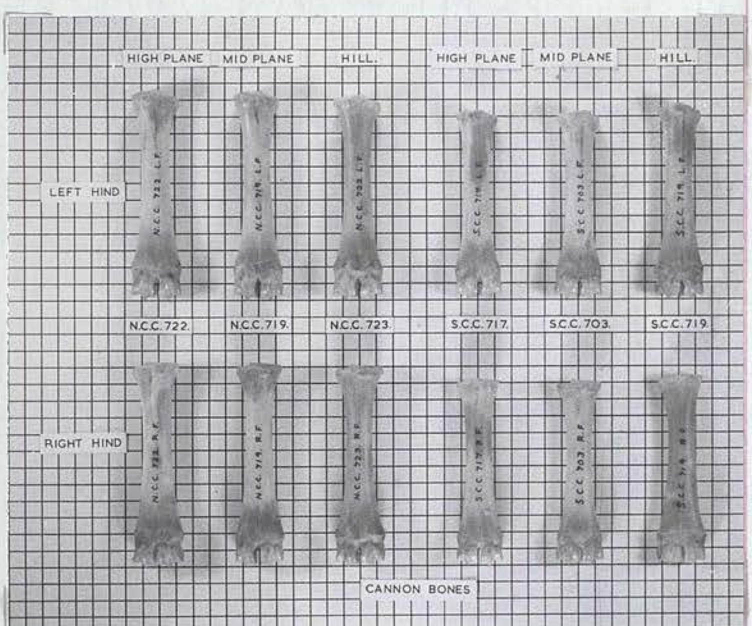


Plate 18A

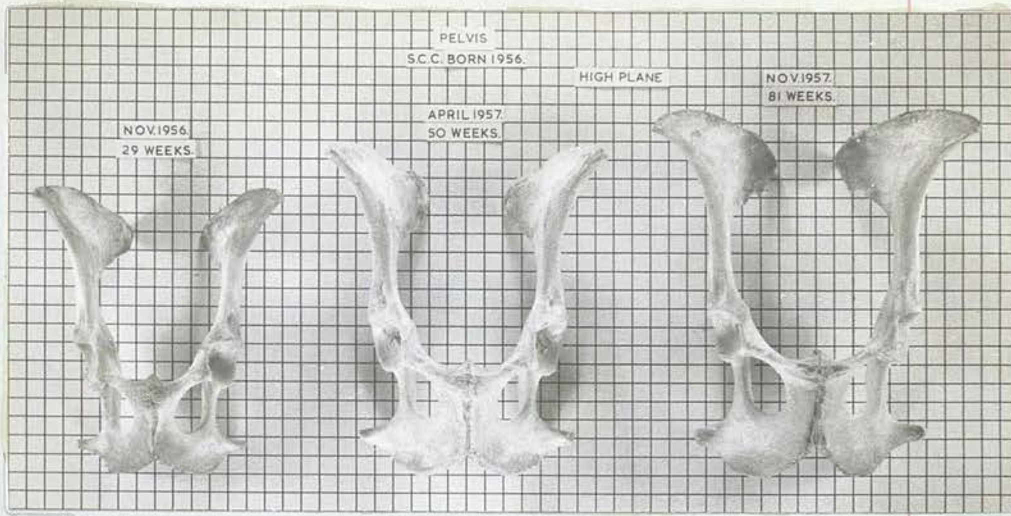
Bones from animals born 1957 and dissected at 80 weeks.

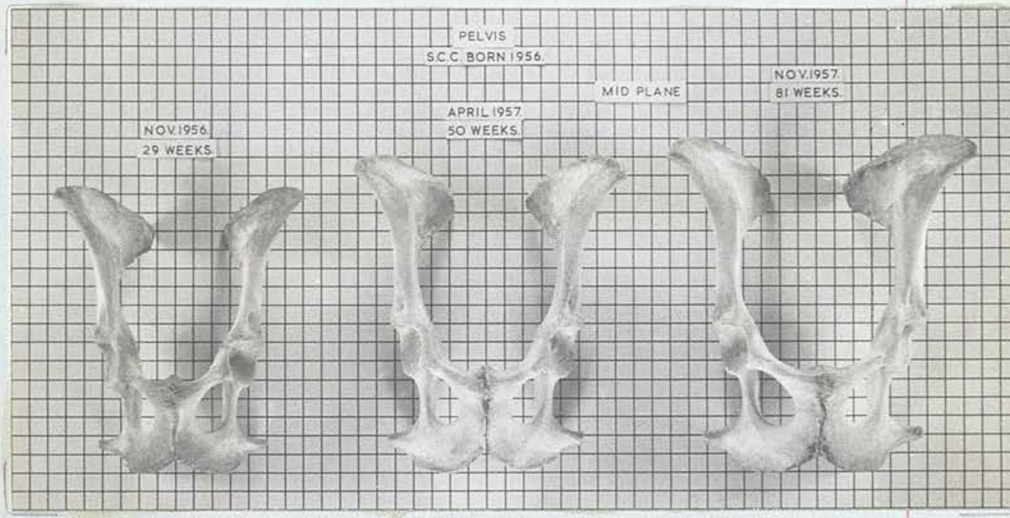




<u>Plate 18B</u>

Bones from animals born 1957 and dissected at 80 weeks.





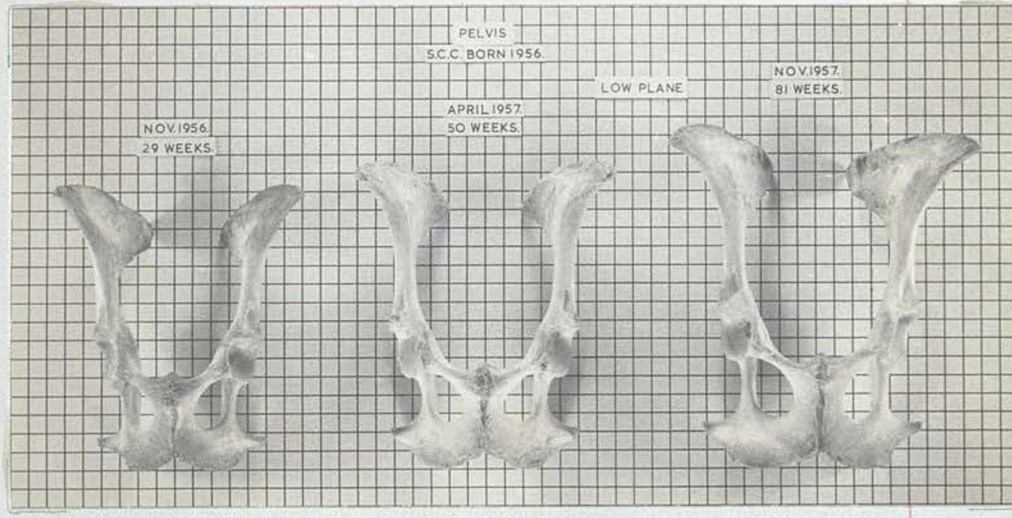
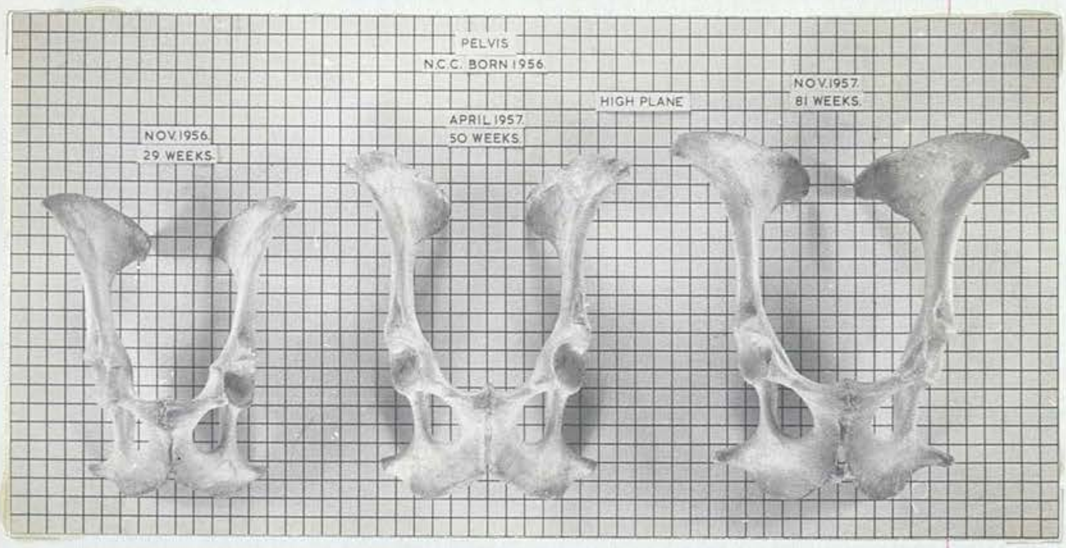
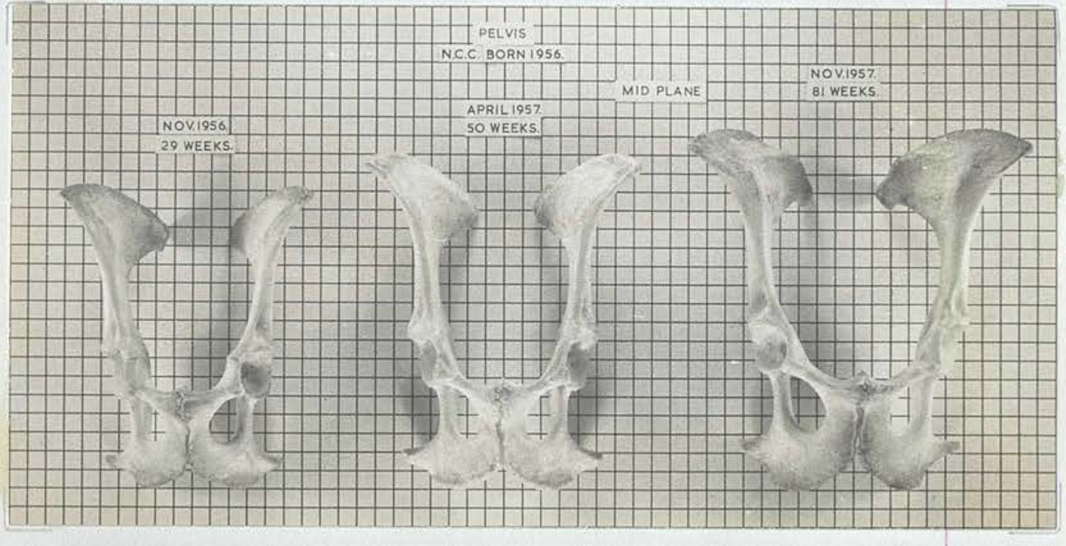


Plate 19

Pelvic bones dissected from S.C.C. animals born 1956.





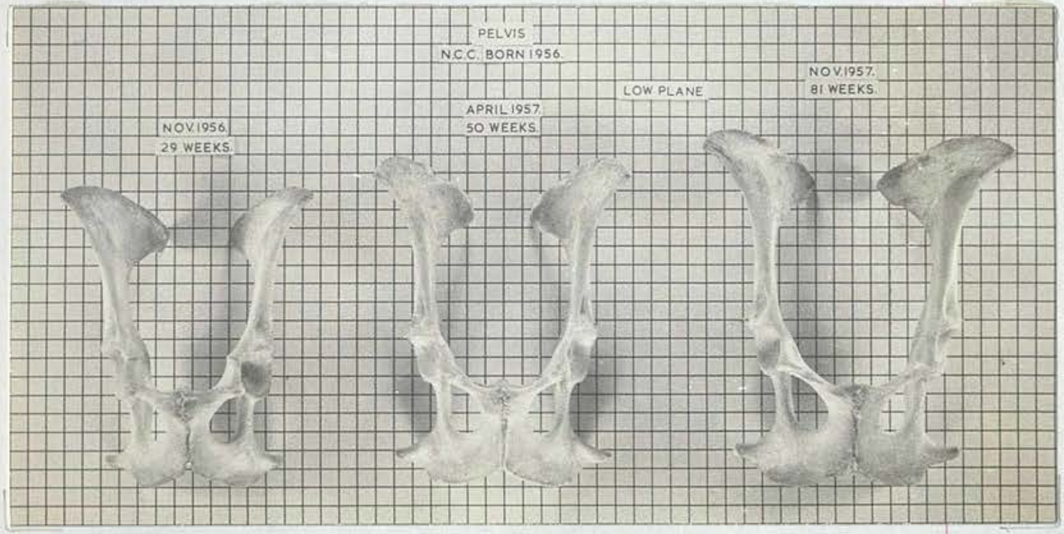
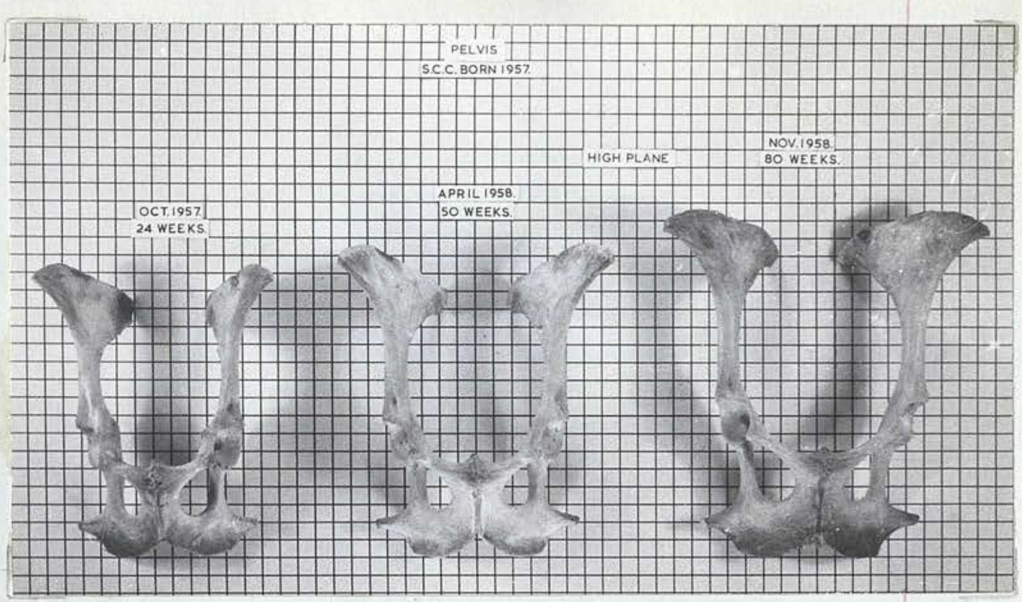
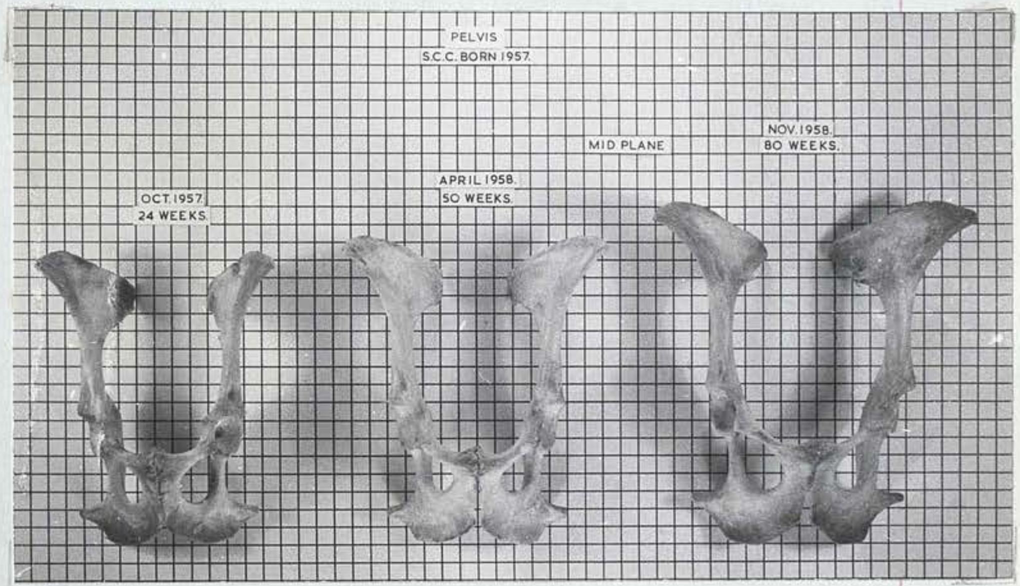


Plate 20

Pelvic bones dissected from N.C.C. animals born 1956.





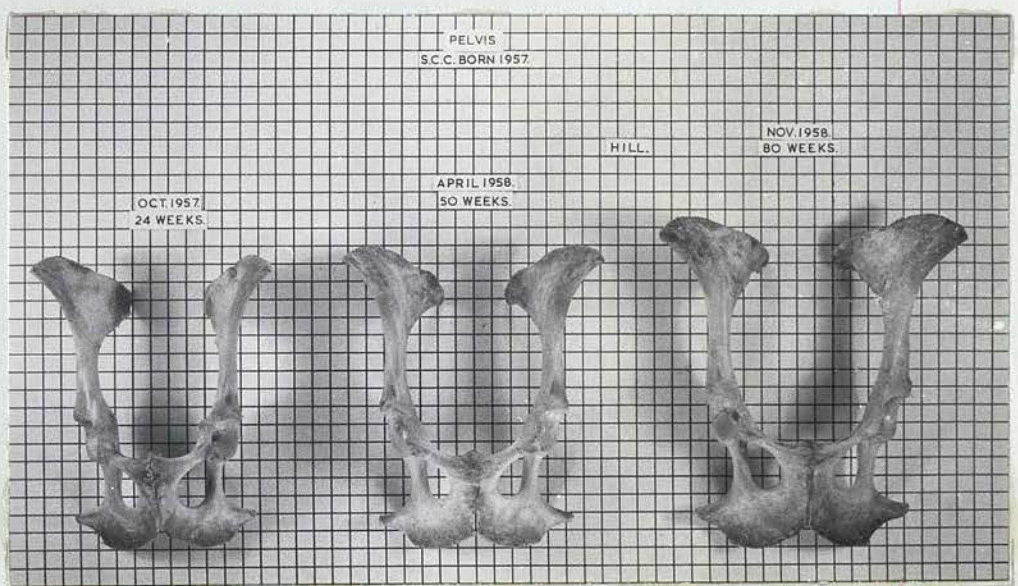


Plate 21

Pelvic bones dissected from S.C.C. animals born 1957.

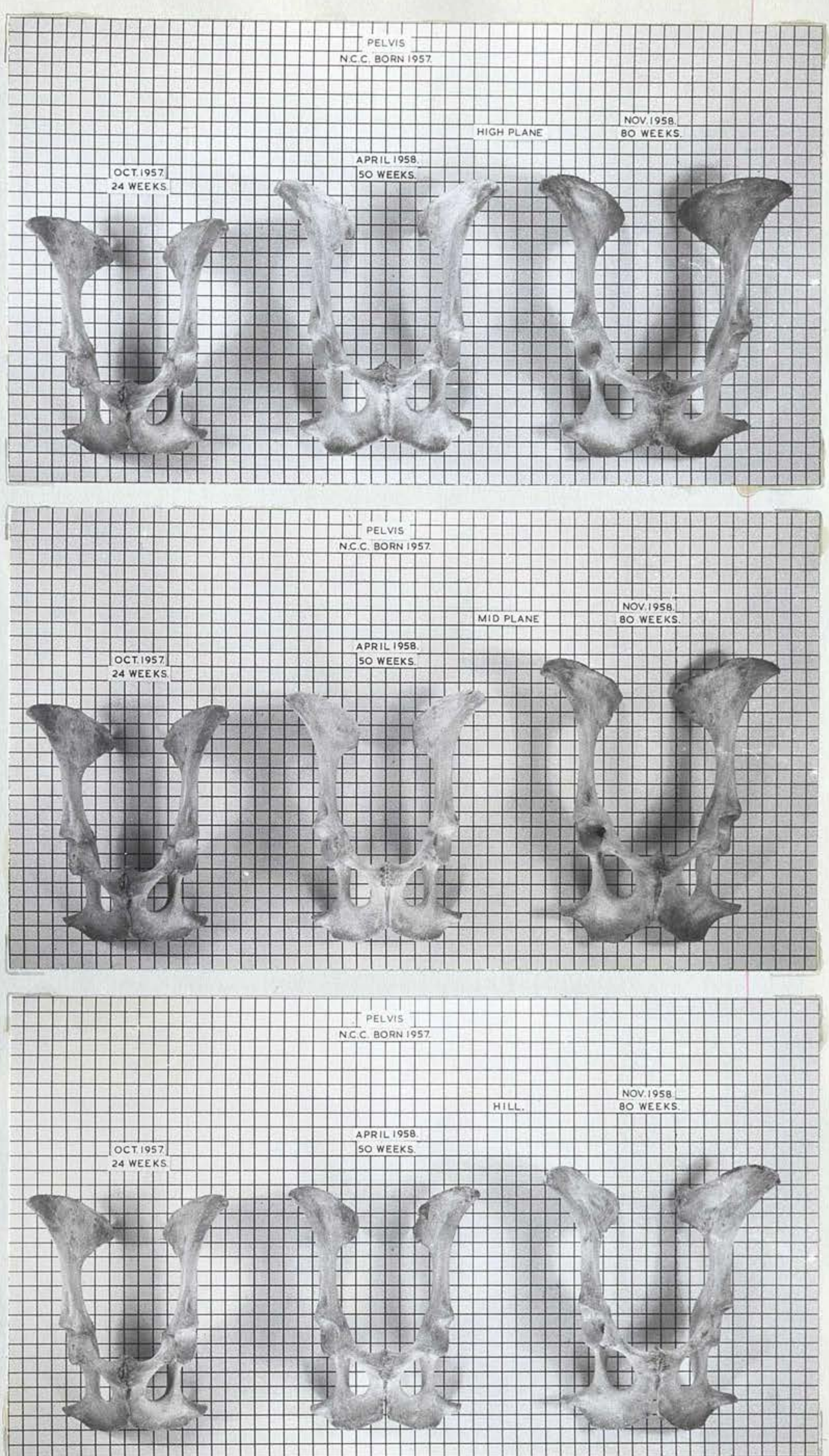
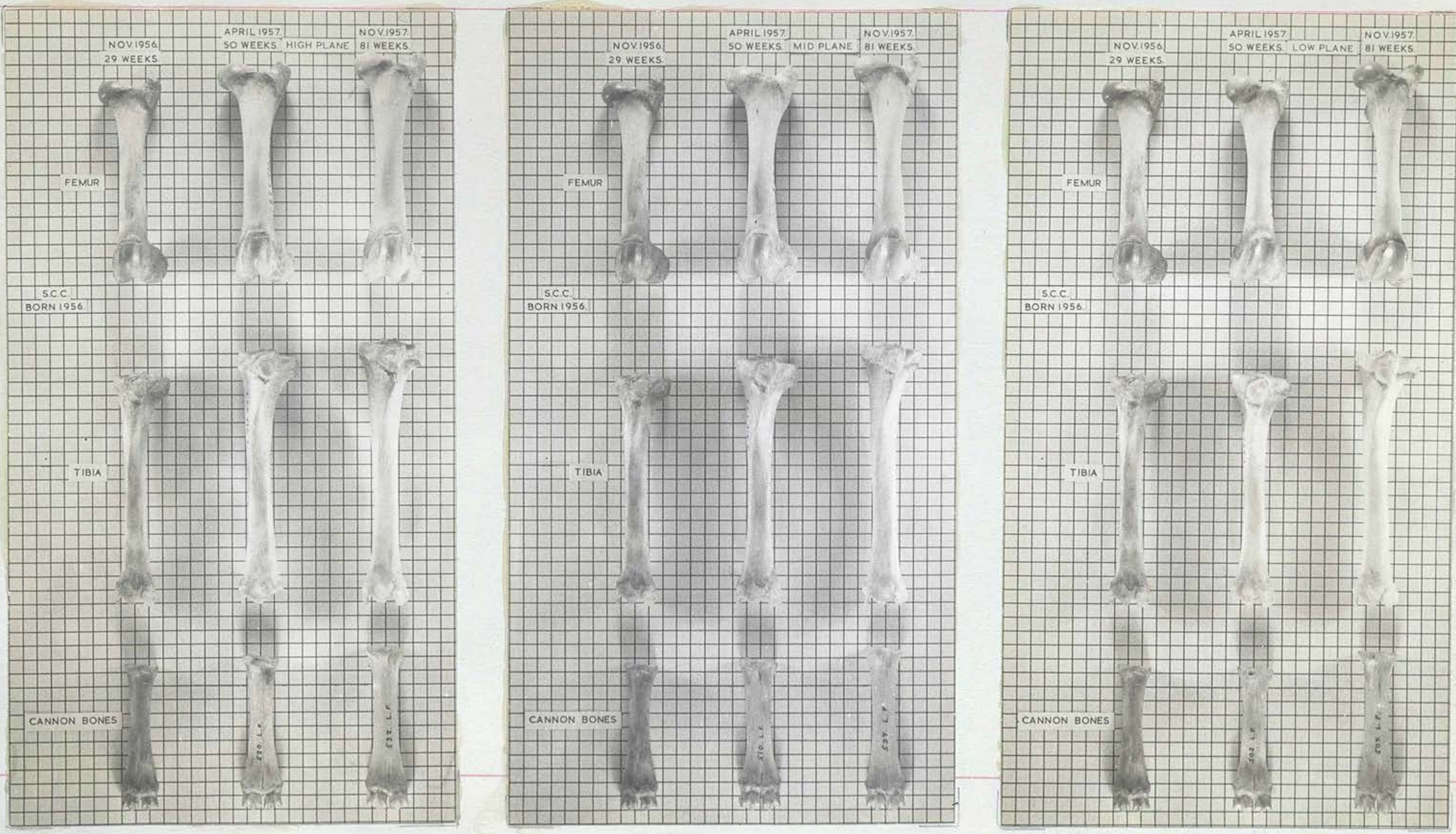


Plate 22

Pelvic bones dissected from N.C.C. animals born 1957.



<u>Plate 23</u>

Limb bones dissected from S.C.C. animals born 1956.

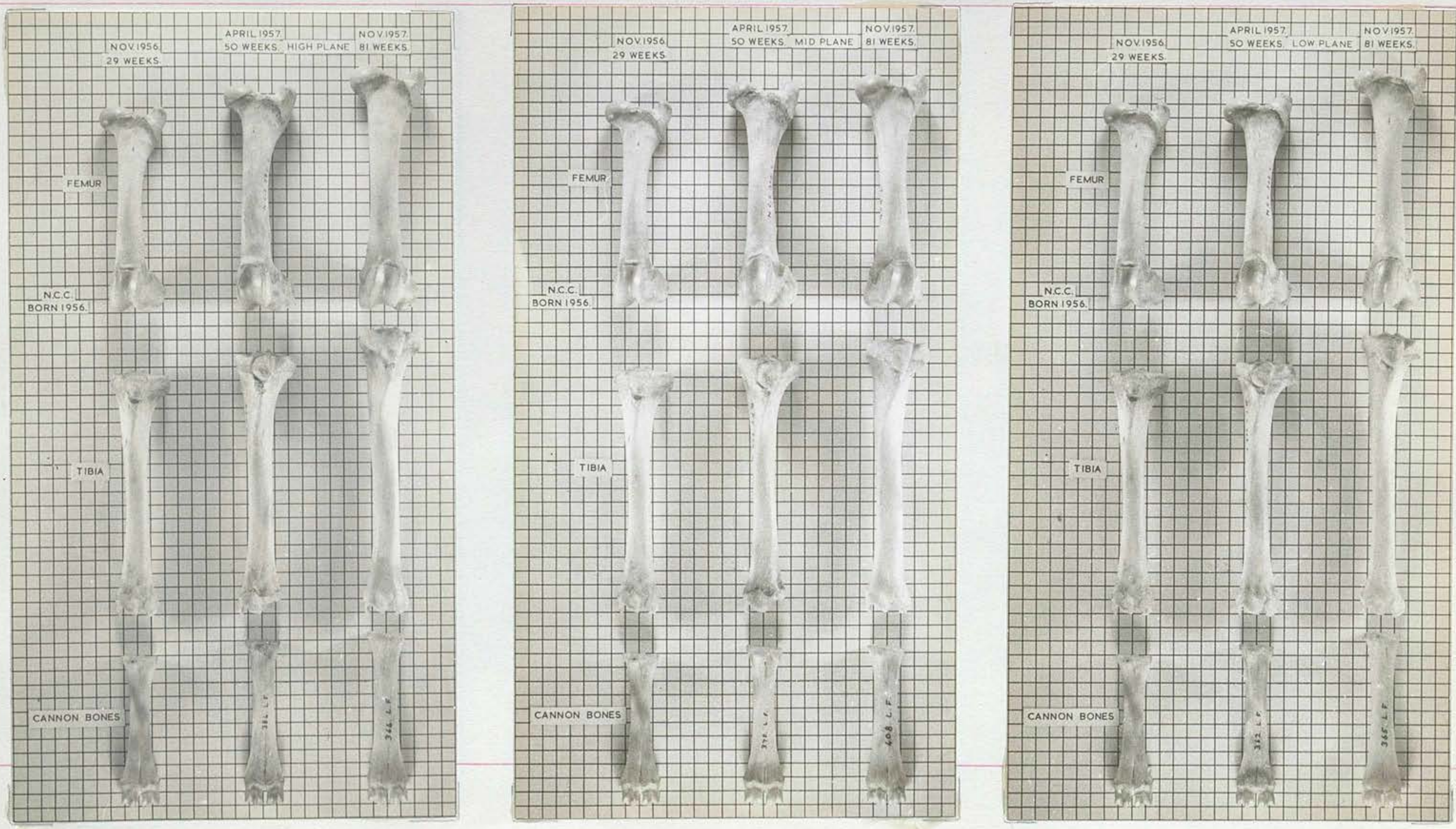


Plate 24

Limb bones dissected from N.C.C. animals born 1956.

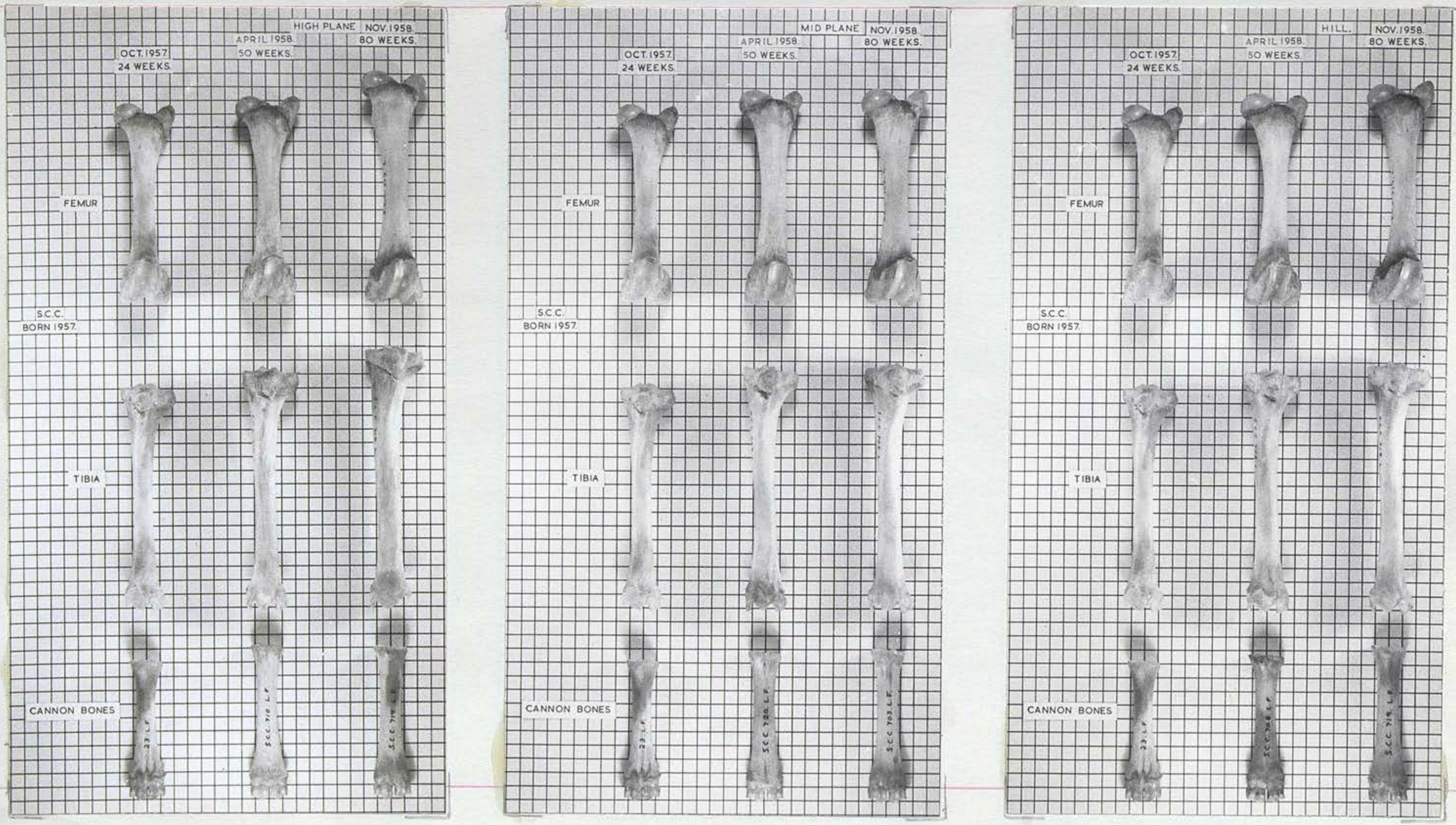


Plate 25

Limb bones dissected from S.C.C. animals born 1957.

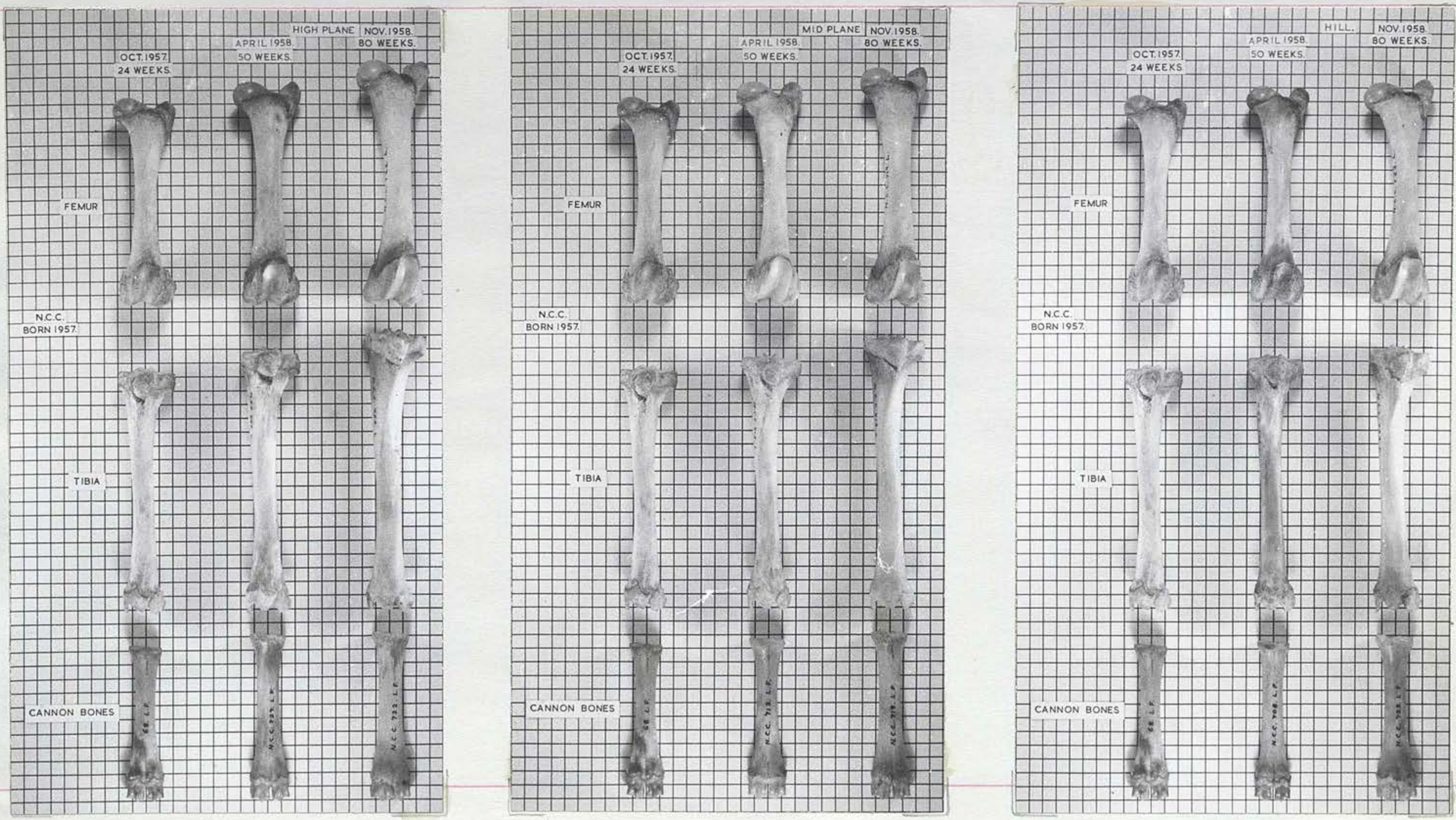


Plate 26

Limb bones dissected from N.C.C. animals born 1957.